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EASTERN
MASSACHUSETTS
REGIONAL
PLANNING
PROJECT

RECOMMENDED HIGHWAY AND TRANSIT PLAN

PREPARED BY THE
BUREAU OF TRANSPORTATION PLANNING & DEVELOPMENT
OF THE
MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
IN CONJUNCTION WITH THE
MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

This report has been prepared by the Bureau of Transportation Planning and Development of the Massachusetts Department of Public Works in conjunction with the Massachusetts Bay Transportation Authority and in cooperation with the Massachusetts Department of Commerce and Development and the Metropolitan Area Planning Council, as a part of the Eastern Massachusetts Regional Planning Project.

The participating agencies conducted a comprehensive transportation-land use planning and development study for a 2,300-square-mile area of Eastern Massachusetts, composed of 152 cities and towns with a population of 3.5 million people. The region includes the Metropolitan areas of Boston, Brockton, Lawrence-Haverhill, Lowell, and portions of Metropolitan Worcester and Providence-Pawtucket.

Of prime importance to the regional planning operation is the fact that the sponsoring agencies have themselves been reorganized or newly created during the life of the study and in every instance the planning function has been strengthened by the General Court.

Overall guidance came from the Planning Project's Policy Committee, consisting of the Commissioner of the Department of Public Works, the Commissioner of the Department of Commerce and Development, the Chairman of the Board of Directors of the MBTA, the President of the Metropolitan Area Planning Council, and the Chairman of the Local Advisory Board.

The planning activity was specifically designed to utilize valuable information obtained by the Boston Regional Survey and the Mass Transportation Demonstration Project conducted by the Mass Transportation Commission (MTC), which has since been discontinued. MTC responsibilities in the EMRPP were reassigned to the Department of Commerce and Development as part of that agency's program for state and area planning. In June 1965, a Transportation Planning Center was established through an agreement between the Department of Public Works and the Department of Commerce and Development to assure that data collected by the Regional Planning Project would be preserved and updated after the project is completed.

Section 1 of Chapter 563 – 1964 Acts of the General Court amends Chapter 16 (Department of Public Works) of the General Laws of Massachusetts in part as follows:

Section 1. Chapter 16 of the General Laws is hereby amended by inserting after section 3 the following section:–

Section 3A. There shall be in the department a bureau of transportation planning and development which shall be under the supervision and control of the commission.

Said bureau shall serve as the principal source of transportation planning in the commonwealth, and in so serving shall conduct research, surveys, demonstration projects and studies in co-operation with the federal government, other governmental agencies, and appropriate private organizations and be responsible for the continual preparation of comprehensive and co-ordinated transportation plans and programs for submission to and adoption by the commission and for such review or consideration by other governmental agencies as may be required by law or deemed appropriate by the commission. Said plans and programs shall be prepared in co-ordination with comprehensive urban development plans and in co-operation with the said other agencies so far as practicable.

(Extracts of pertinent Federal statutes are reproduced on the inside back cover of this document.)

The Commonwealth of Massachusetts
Department of Public Works
Office of the Commissioner
100 Nashua Street, Boston 02114

January 31, 1969

His Excellency Francis W. Sargent
Governor of Massachusetts
Executive Department
State House
Boston, Massachusetts 02133

Dear Governor Sargent:

A Recommended Highway and Transit Plan report for the Eastern Massachusetts Region is herewith transmitted. Highway, transit, water and sewer, open space and community renewal planning, are parts of a comprehensive plan that will determine what a region will be like in the future. None of these aspects can be adequately planned as separate undertakings. The Eastern Massachusetts Regional Planning Project has produced a comprehensive regional plan and development program, with special emphasis on the region's transportation needs.

The Department's Bureau of Transportation Planning and Development assisted by the Massachusetts Bay Transportation Authority were the principal agencies responsible for producing this plan. As one of six urban transportation studies currently being completed for the Department of Public Works, this report is a major contribution to our goal of a statewide system designed to meet the projected needs of Massachusetts during the next twenty-one years.

The recommended plan is unique as it has kept in balance the addition of new expressways. It has accomplished this balance by seeking solutions to anticipated traffic congestion by planning the use of extended transit on existing railroad rights of way, with provision for parking on the perimeter of the regional core.

This plan is recommended to the communities as a realistic, efficient, desirable solution of the major transportation problems in the Eastern Massachusetts Region.

Very truly yours,

Edward J Ribbs

EDWARD J. RIBBS
COMMISSIONER

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RECOMMENDED
HIGHWAY and TRANSIT PLAN

Prepared by

Massachusetts Department of Public Works
Bureau of Transportation Planning and Development
Transportation Planning Center
80 Broad Street, Boston, Massachusetts

1968

developed in conjunction with
Massachusetts Bay Transportation Authority

and in cooperation with
Massachusetts Department of Commerce and Development
Metropolitan Area Planning Council

and with

U. S. Department of Housing and Urban Development
U. S. Department of Transportation
Federal Highway Administration
Bureau of Public Roads

through the

EASTERN MASSACHUSETTS REGIONAL PLANNING PROJECT

The preparation of this report was financially aided through a Federal grant from the Urban Renewal Administration of the Department of Housing and Urban Development under the Urban Planning Assistance Program authorized by Section 701 of the Housing Act of 1954, as amended, and through Highway Planning and Research funds made available by the Department of Transportation, Federal Highway Administration, Bureau of Public Roads.

Publication of this document has been approved by Alfred C. Holland, State Purchasing Agent

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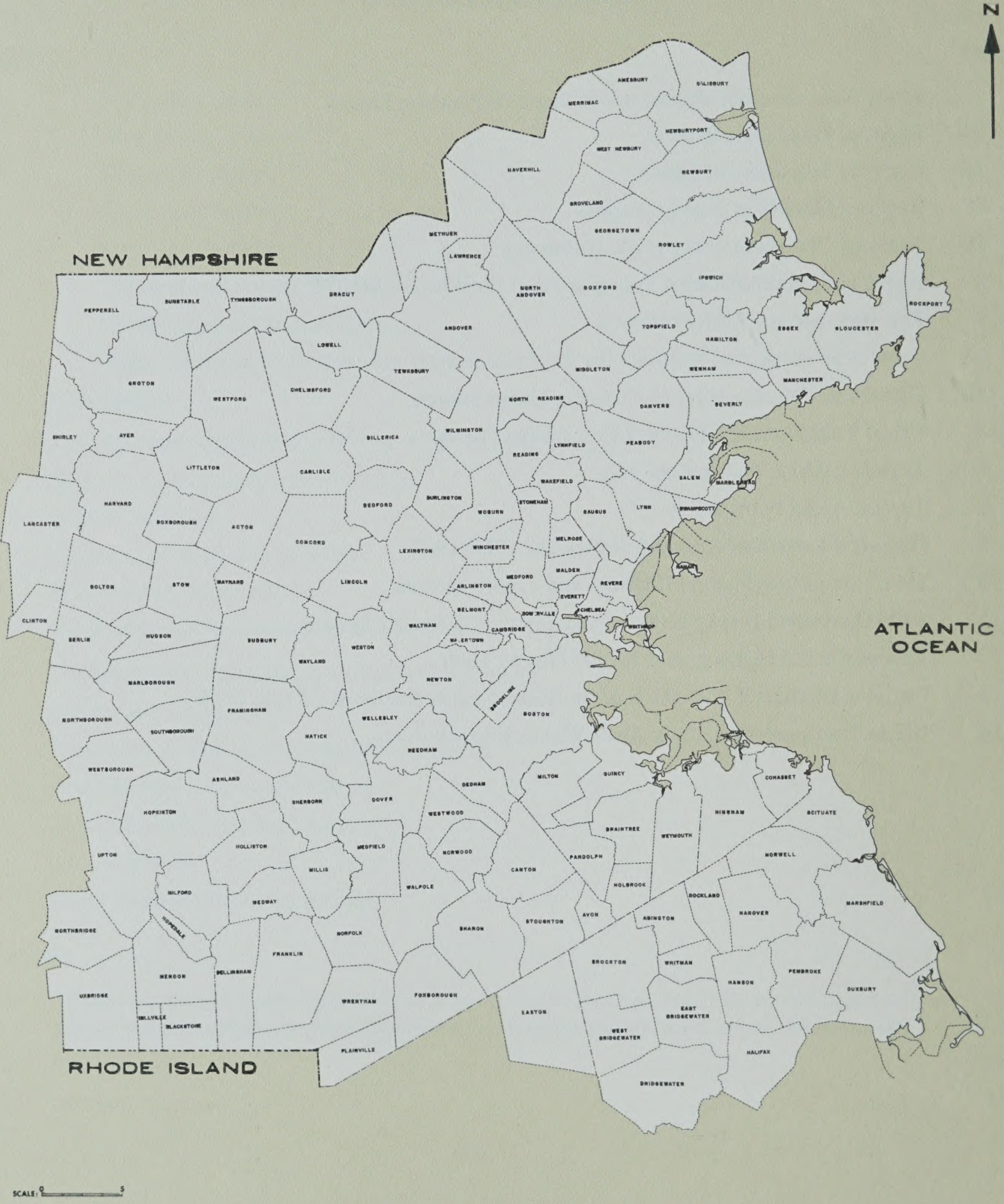

FIGURE I

STUDY AREA

EASTERN MASSACHUSETTS REGIONAL PLANNING PROJECT

I. SUMMARY

The comprehensive transportation recommendations presented in this report are designed to accommodate the transportation and development needs of the eastern Massachusetts region in 1990. (See the map of the state and the region in Figure 1.) Projects already committed for construction include 47.1 miles of new and 26.9 miles of upgraded expressways and 25.6 miles of new and 2.0 miles of upgraded rapid transit facilities.* The expressways will cost $235,163,000 and the transit facilities will cost $386,500,000.

In addition to these committed projects, the Eastern Massachusetts Regional Planning Project (EMRPP) recommendations for the period 1968-1975 include 33.1 miles of new and 29.2 miles of upgraded expressways and 9.0 miles of new rapid transit facilities. Based on current dollar value, the estimated total cost of this recommended short-range program is $576,962,000. The total includes $530,962,000 for expressways and $46,000,000 for rapid transit.

For the long-range program (1975-1990), 146.1 miles of new and 40.8 miles of upgraded expressways and 29.5 miles of new and 11.0 miles of upgraded rapid transit facilities are recommended. The cost of this program includes $580,340,000 for expressways and $312,400,000 for rapid transit.

The total cost of recommended short-range and long-range programs (not including committed projects) would be $1,469,702,000: $1,111,302,000 for expressways and $358,400,000 for rapid transit facilities. (See Chapter VI for details.)

These large expenditures are necessary for the region's future growth. The dynamic expansion that Route 128 produced can be repeated in other areas of comparable potential. Recent developments along Interstate Route 495 (I-495) illustrate what can be expected. In addition, existing and forecast areas of congestion must be relieved, particularly if we are to prevent strangulation of the core area.

The magnitude of the region's growth and the resulting increase in travel are reflected in the following abstract of 1963 base year survey facts and 1990 forecasts (see Figures 2A-2D).

REGIONAL ABSTRACT OF 1963 FACTS AND 1990 FORECASTS

- Population is expected to increase 34 percent, from 3,540,550 in 1963 to 4,733,000 in 1990.
- Employment is projected to climb 39 percent, from 1,297,000 in 1963 to 1,801,000 in 1990.
- The 1963 median family income of $6,515 is projected to rise to $13,260 per family by 1990 (measured in current dollars).
- Car ownership will rise from one car for every 3.3 persons in 1963 to one car for every 2.1 persons in 1990 – an increase of 108 percent in the number of cars, from 1,070,000 cars in 1963 to 2,220,000 in 1990.
- Travel by transit is expected to reverse its downward trend (from 1950 to 1960 there was a 35 percent loss in patronage). Current indications are that revitalization of these facilities is beginning to have beneficial effects on the number of riders. A 45 percent growth in transit travel is expected.

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*In describing the highway portion of the program, this report discusses only the expressways. The entire highway system includes arterials and other major streets as an integral part of the system.

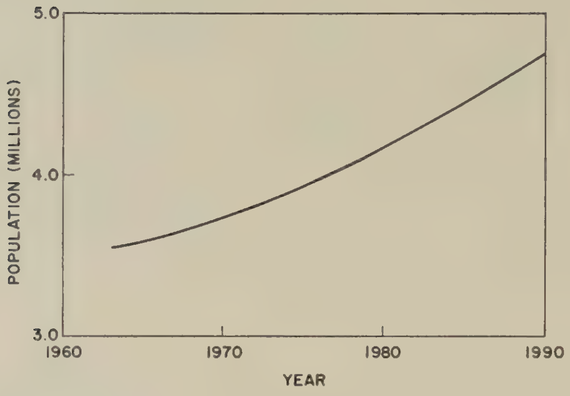

FIGURE 2A: REGIONAL POPULATION GROWTH

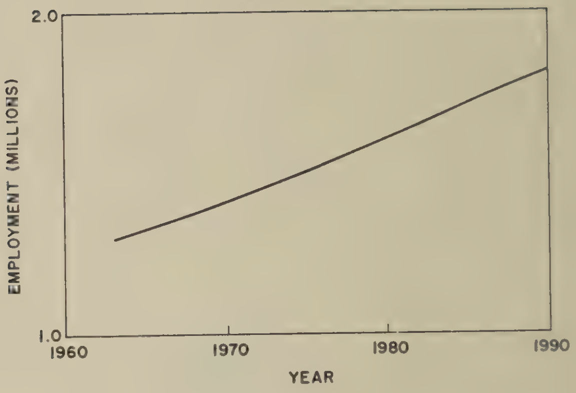

FIGURE 2B: REGIONAL EMPLOYMENT GROWTH

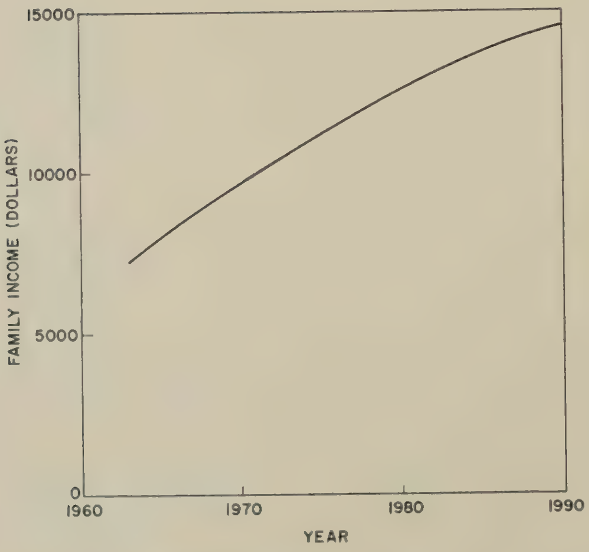

FIGURE 2C: REGIONAL GROWTH IN FAMILY INCOME

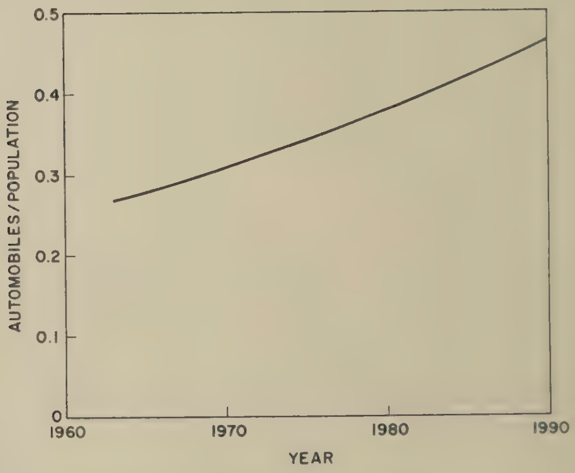

FIGURE 2D: REGIONAL GROWTH IN AUTOMOBILE OWNERSHIP

- In the study area in 1963, there were 40,000,000 vehicle miles of travel each day. By 1990, this figure will double to 80,000,000 vehicle miles daily.

- The 1990 forecast indicates that parking requirements in Boston proper will be more than double the space required in 1963.

These forecasts indicate tremendous increases in highway traffic congestion and driver frustration if the problems are not met with intelligent planning. Desirable growth in industry, commerce, recreation, and residential development is intimately tied to the transportation system; conversely, the transportation system must be tied to the development of these activities.

The central area of the region, focusing on downtown Boston, is one of five in the United States currently served by rapid transit. Rail and bus transportation serve much of the region, but unfortunately, the system does not extend to outlying areas where rapid growth has occurred during the last two decades. Furthermore, the existing system is inadequate to serve current needs. As a consequence of these deficiencies, the highway system dominates the region's development.

Neither highways nor transit alone can adequately serve the region completely. For an efficient and economical regional transportation network, a balance is needed between these ground transportation systems. Highways should continue to dominate in the less dense areas of the region, while transit is needed as a supplement to carry the heavy commuter flow into and out of Boston and as a service to the inner city residents. Development of such balances has been an objective of this study's proposed additions, improvements, and extensions.

To prepare a comprehensive transportation plan for the future, several concepts of regional development were evaluated. These concepts were based upon differing goals and differing tendencies toward corridor development, dispersed development, and development of multiple centers of activity. After an examination in depth of the four most promising concepts, the "Controlled Dispersal" and "Composite" Plans were selected as the most desirable and feasible alternatives. Accordingly, detailed expressway and transit networks were developed for these alternatives and the forecast 1990 travel was assigned to each alternative system.

As tested, neither plan proved to be completely adequate, because the projected 1990 traffic loads are greater than the capacity of certain proposed highways. However, an analysis of the alternatives resulted in a recommended plan that combines the tested and proven facilities of both plans. As a consequence, the recommended plan is more extensive than either alternative.

The proposed expressway system preserves the present radial and circumferential pattern (see Figure 3). The circumferential pattern is strengthened by the addition of the Inner Belt and a 66-mile Middle Circumferential Expressway between Route 128 and I-495 and parallel to them. A major new radial expressway is added in the Southwest Corridor.

The proposed rapid transit system continues the existing radial patterns, but extends lines much farther into the suburbs. The downtown Boston distribution is improved by a new tunnel linking two of the lines.

In the continuing transportation planning process, the recommended systems will be tested for load distribution by the traffic assignment process. Except for possible minor changes required by analysis of the load distribution, modifications and refinements to the expressway system become matters of detailed location of recommended roads in the corridors and the determination of required supplementary arterial improvements. Anticipated modifications and refinements to the recommended rapid transit

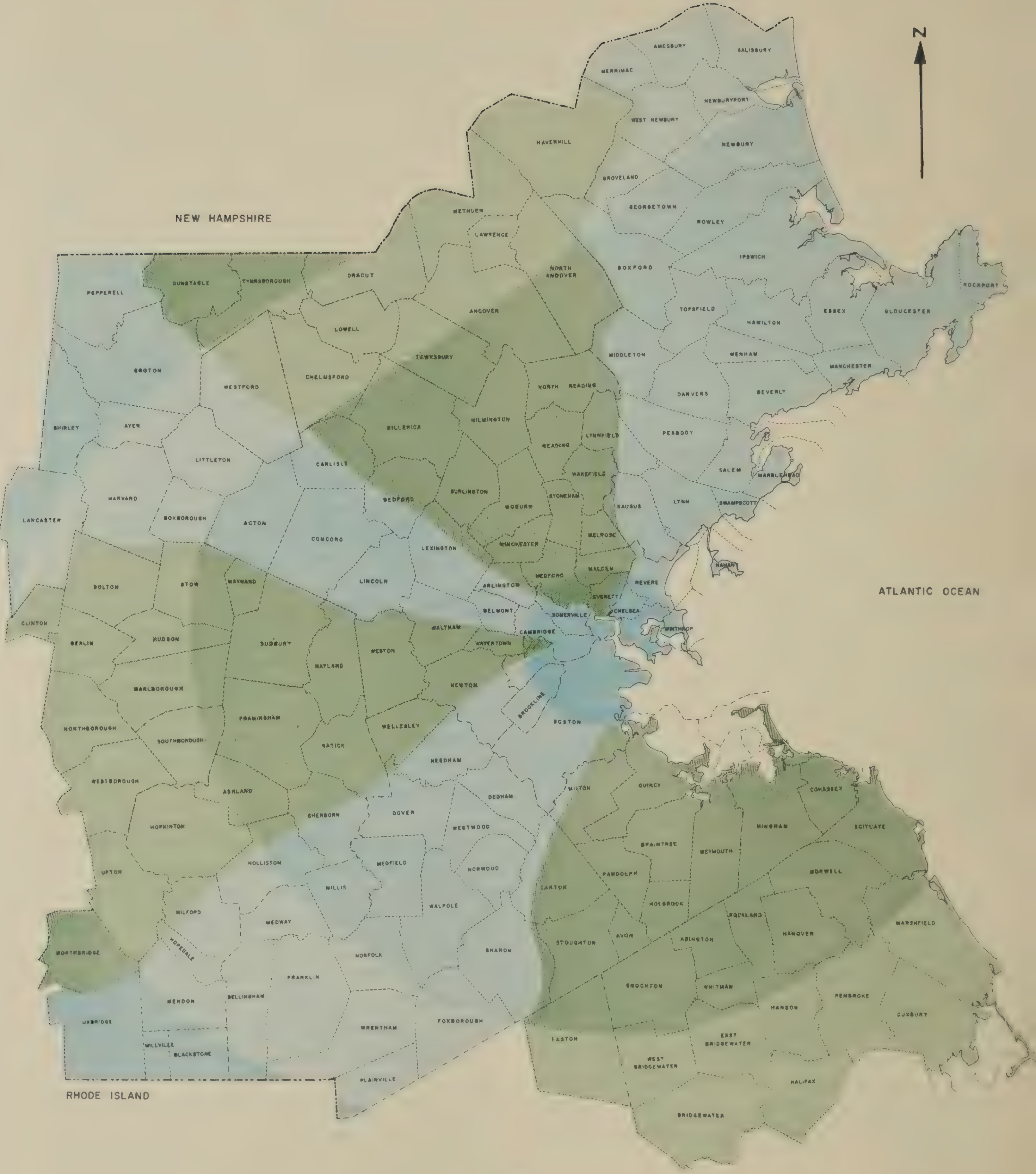

FIGURE 3

RADIAL AND CIRCUMFERENTIAL TRANSPORTATION CORRIDORS
EMRPP

system, as well as the length of the extensions, will be determined based upon economic feasibility.

In addition to the orderly development of the major elements of the expressway and transit systems outlined in this report, the objective of a balanced transportation system cannot be reached without efficient traffic operations. A high proportion of highway travel occurs on roads other than expressways. Strong efforts must be made to provide a level of service on each segment of the arterial system that is appropriate to the facility and its load. The increasing interest in the federally aided TOPICS Program (Traffic Operations Program for Increasing Capacity and Safety) should give traffic operations an appropriate place in the highway program.

The recommendations of this report are based on a comprehensive transportation study. The procedural details and methods of analysis and testing of networks are contained in the chapters that follow. The recommendations are the end result of this transportation study.

Continuing effort is required to test, adjust, refine, and update the plan as necessary to take advantage of new technology and transportation service concepts and be directed as accurately and intelligently as possible toward the region's most desirable development. An effective long-range plan must move its target date ahead with the passage of time. The plan, therefore, is not a static document, but a vibrant, current guide to a better region.

SPECIFIC RECOMMENDATIONS

Following is a capsule list of the specific recommendations, which are illustrated in Figure 12 on page 115.

COMMITTED PROJECTS (1968)

Northeast Corridor

- Construct I-95 from Danvers to Revere.
- Reconstruct I-95 from Salisbury to Danvers.

Northern Corridor

- Complete I-93 from Medford to Somerville.
- Widen the I-93 bridge over the Merrimack River.
- Extend the Orange Line rapid transit from Haymarket Station to Oak Grove.
- Eliminate the North Station-to-Everett elevated structure.

Northwest Corridor

- Rebuild Route 2 from Route 128 in Lexington to Alewife Brook Parkway in Cambridge.
- Extend the Red Line rapid transit from Harvard Square to Alewife Brook Parkway.

Western Corridor

- Complete I-290 from the regional boundary in Northborough to I-495 in Marlborough.

Southwest Corridor

- Relocate the existing Orange Line rapid transit from Back Bay to Forest Hills and extend the line to the VFW Parkway in West Roxbury.

Southeast Corridor

- Extend the Red Line rapid transit from Andrew Station to South Braintree.
- Upgrade the Ashmont-Mattapan streetcar line to high-platform rapid transit.

Outer Circumferential Corridor

- Complete I-495 from Route 9 in Westborough to I-95 in Foxborough.

SHORT-RANGE PROGRAM (1968-1975)

Northeast Corridor

- Construct a Beverly-Salem Connector.
- Construct a Revere Beach Connector.
- Upgrade I-95 from Revere to Chelsea.
- Extend the Blue Line rapid transit from Wonderland Station to Pines River.

Northwest Corridor

- Rebuild Route 2 from Route 211 in Acton to Route 128 in Lexington.

Southwest Corridor

- Construct I-95 from Canton to the Inner Belt in Roxbury.
- Extend Orange Line rapid transit from the VFW Parkway to Route 128 in Needham and from Forest Hills Station to Route 128 in Canton.

Southeast Corridor

- Construct the Hingham Spur.

Regional Center

- Construct the Inner Belt.
- Improve the Central Artery to Interstate Standards.
- Continue I-95 from the Southwest Expressway/Inner Belt Interchange to the Central Artery.

Middle Circumferential Corridor

- Rebuild Route 128 from Lynnfield to Beverly.

LONG-RANGE PROGRAM (1975-1990)

Northeast Corridor

- Construct a New Harbor Crossing.
- Construct a Shore Expressway from the New Harbor Crossing to I-95 in Saugus.
- Extend the Blue Line rapid transit from Pines River to Salem.
- Construct a branch from the Blue Line rapid transit to Logan Airport.

Northern Corridor

- Extend the Orange Line rapid transit from Oak Grove to Route 128 in Wakefield.

Northwest Corridor

- Construct a new Route 2 from Alewife Brook Parkway to Somerville at the Inner Belt.
- Extend the Red Line rapid transit from Alewife Brook Parkway to Route 128 in Lexington.

Western Corridor

- Construct a Western Expressway from Weston at Route 128 to Marlborough at I-495 and I-290.
- Upgrade the Riverside Line to high-platform rapid transit.
- Extend the Riverside Line rapid transit from Riverside Station to the new Middle Circumferential Expressway near the Wellesley-Natick line.

Southwest Corridor

- Construct a new Route 209 from Uxbridge at Route 146 to Westwood at Route 128.

Southeast Corridor

- Construct the Shawmut Trail from Braintree to Hingham.
- Construct the Scituate Spur.
- Provide additional capacity on the Southeast Expressway from Braintree to Boston.
- Widen Route 3 from Duxbury to the Hingham Spur.
- Extend the Red Line rapid transit from South Braintree to South Weymouth.

Regional Center

- Construct approaches to a New Harbor Crossing.
- Connect the Riverside Line with the East Boston Blue Line.

Middle Circumferential Corridor

- Construct a Middle Circumferential Expressway from I-95 in Danvers to Route 3 in Norwell.
- Upgrade Route 128 from Beverly to Gloucester.

Outer Circumferential Corridor

- Construct a Woonsocket Connector from I-495 in Bellingham to the Rhode Island state line.

II. INTRODUCTION

"Population explosion" has become a familiar phrase that dramatically emphasizes many of the problems of the 20th century world. Recent news stories and pictures illustrated the occasion when the United States population reached 200 million.

In the eastern Massachusetts region, where this nation had its beginnings, a population growth rate as high as the national rate is not anticipated. However, automobile ownership and total vehicle miles of travel will increase at much the same rate as in the rest of the country. In evaluating the transportation problems of the eastern Massachusetts region, it is well to bear in mind that this region, which embraces less than 29 percent of the state's land and water areas, contains 68 percent of the population at more than three times the state's average density. A map of the region is given in Figure 4.

Transportation is fundamental to the development of a region. It provides the means for people and goods to move from one activity to another. Transportation is to the region what the bloodstream is to the human body. Comprehensive planning of transportation facilities is the subject of this report.

Hundreds of millions of dollars have been expended in the construction of expressways, access roads, and parking facilities in and around the core areas of the eastern Massachusetts region. Despite these vast expenditures, there is still severe congestion, and traffic moves at a slow pace during the morning and evening peak hours. At the hours of maximum movement, minor accidents and bad weather too often cause traffic jams.

Automobile ownership in Massachusetts, as in the nation, has increased faster than the population. From 1940 to 1960, the number of automobiles in use in the state increased from about 793,000 to 1,606,000. It is anticipated that this number will be approximately 3,200,000 by 1990 (see Figures 5A and 5B). There has been more than one car per household since 1960, and this ratio will increase. The total travel on Massachusetts roads in 1940 was approximately 9 billion vehicle miles. The forecast for 1990 is 37 billion vehicle miles. The effect on the metropolitan area of this large increase in automobile travel is profound.

An economic and physical limit can be reached in the construction of expressways, with their extensive requirements for land and the accompanying construction of large parking facilities in the central business districts. To avoid this extreme limit, the transportation planner faces difficult and complex problems. He is increasingly aware that balances must be struck between highways and new kinds of rapid transit in many metropolitan areas.

Until recently, there has been little concern with the design of complete urban transportation systems, although the fact is generally appreciated that all people and institutions in a metropolitan region are parts of one large community. "Suburbs" and "city" are commonly understood as terms that refer to parts of a larger whole. It has also been clear that the people, businesses, and specialized activities that make up the metropolis are held together by the channels and vehicles that constitute its transportation system.

In spite of this knowledge, transportation networks have not been planned as large systems like electric, telephone, or water services. It has not been possible until recently to measure or predict the effects of one new transportation facility on the performances of all other facilities. Today, with new large computers and new mathematical descriptions, it becomes possible to begin to describe the very complex functioning of regional networks and, therefore, to plan logically for an entire region rather than for one small area or one new facility.

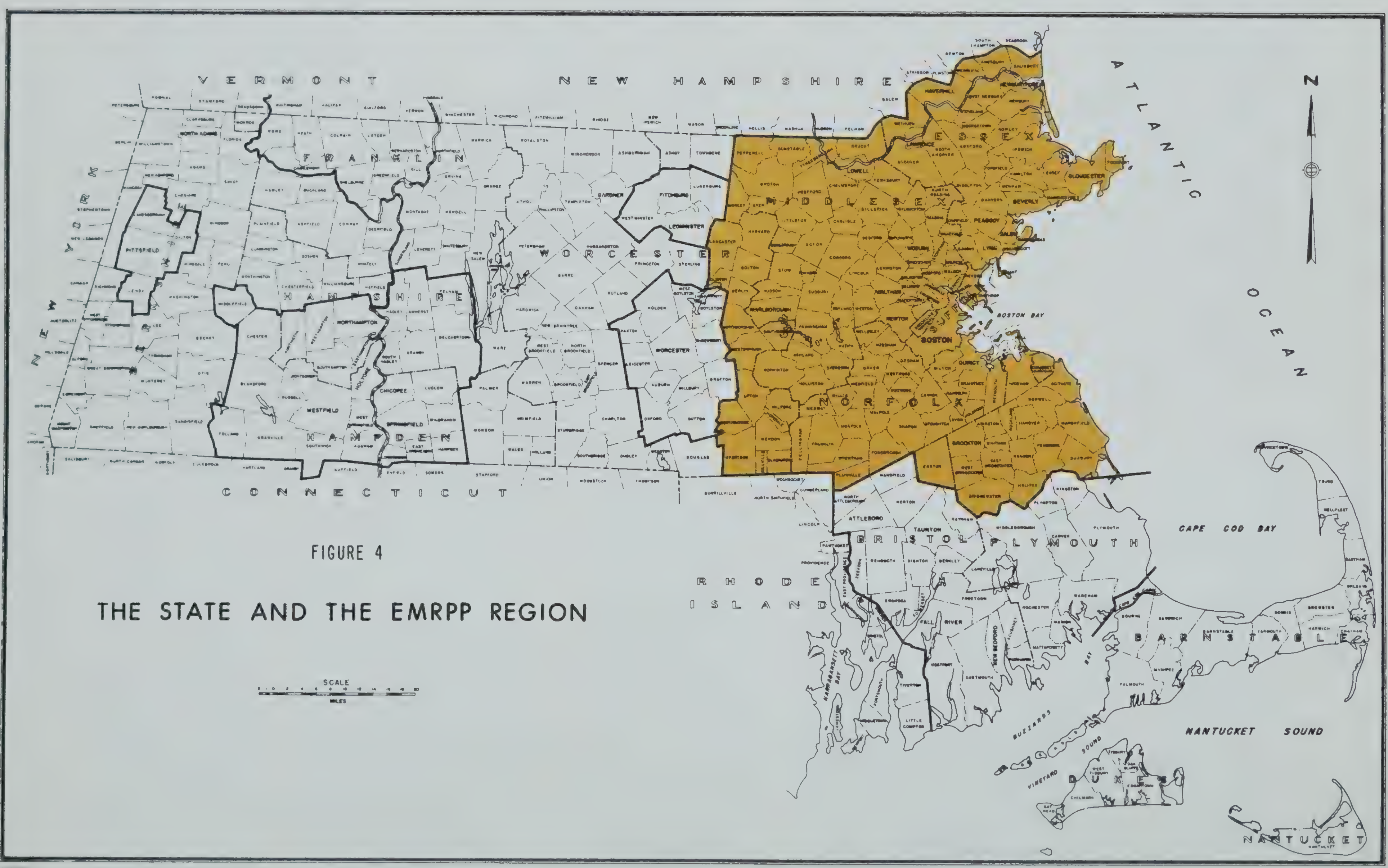

FIGURE 4

THE STATE AND THE EMRPP REGION

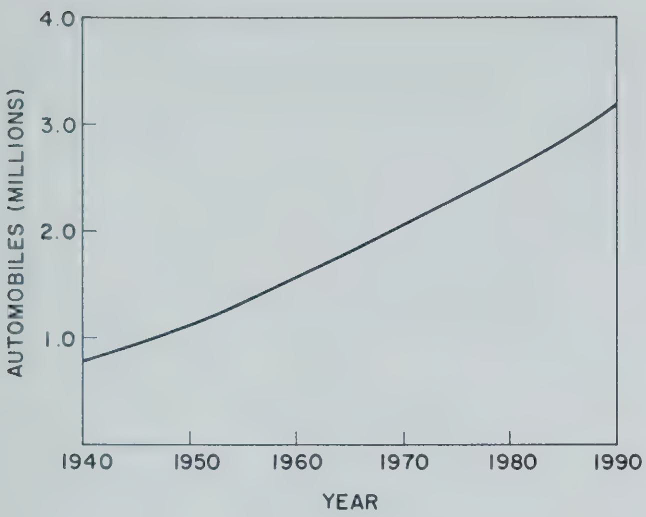

FIGURE 5A: GROWTH IN NUMBER OF AUTOMOBILES IN MASSACHUSETTS

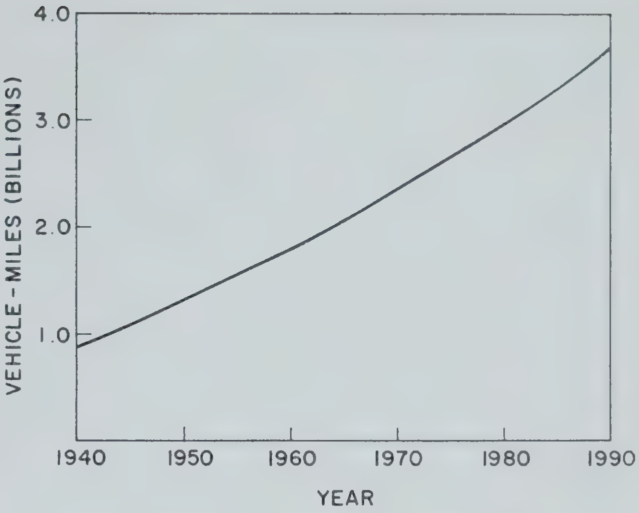

FIGURE 5B: GROWTH IN VEHICLE-MILES OF TRAVEL IN MASSACHUSETTS

BACKGROUND

The Commonwealth of Massachusetts, through its agencies, commissions, and departments, has been a leader in transportation planning and construction. Extensive planning studies have been made for the expressway system and the extensions to the transit system now under construction or proposed.

Federal legislation of recent years, supported with large-scale programs of matching funds for planning and construction, complements the Commonwealth's efforts of the past 35 years. Funds authorized by the Housing Act of 1961 and the several Federal Highway Acts have been a substantial source of federal aid for regional planning and mass transportation demonstration experiments.

The Eastern Massachusetts Regional Planning Project (EMRPP) indirectly had its origin in 1959. In that year, the Governor and the General Court, recognizing the necessity for obtaining coordination and cooperation in comprehensive planning for both public and private transportation, established a new state agency, the Mass Transportation Commission. Thus was formally recognized the need for study and planning in the transportation field. This commission published several excellent reports, particularly *The Boston Regional Survey* and *Mass Transportation in Massachusetts.*

The commission's findings, as well as the comprehensive planning required by the U.S. Bureau of Public Roads in the allocation of federal highway funds, dictated that an updating of highway plans was urgently needed within a total transportation framework. The need for formal transportation planning gave rise to an interagency agreement to produce a comprehensive development plan for the eastern Massachusetts region. The agreement, which was made on November 30, 1962, between the Mass Transportation Commission and the Department of Public Works, established the Boston Regional Planning Project.

Early in 1964, the agreement was modified and the newly created Metropolitan Area Planning Council was included in the project's executive committee. The Mass Transportation Commission was abolished after completion of its major demonstration project late in 1964. Its remaining functions were transferred to the new Department of Commerce and Development. The legislature that directed this change also established the Bureau of Transportation Planning and Development within the Department of Public Works and reorganized the Metropolitan Transit Authority into today's Massachusetts Bay Transportation Authority.

These changes in the transportation planning groups encouraged a wider participation in the regional planning project. Therefore, a new interagency agreement was drawn up, which included:

- the Department of Public Works (DPW);
- the Department of Commerce and Development (DCD);
- the Massachusetts Bay Transportation Authority (MBTA); and
- the Metropolitan Area Planning Council (MAPC).

This September 1965 agreement terminated the Boston Regional Planning Project and instituted in its place the Eastern Massachusetts Regional Planning Project. (See Appendix A for a copy of the agreement.) All four agencies contributed to carrying out the work of the project. The results obtained by one group were frequently essential to the work of another group.

This report is the result of the specific effort assigned to the DPW staff to develop, test, evaluate, and adjust transportation networks and to the MBTA to prepare mass transportation plans in its district. These plans were developed in accordance with regional development plans prepared by DCD and MAPC.

Chapter III discusses basic planning studies and the procedures used in forecasting travel. Chapter IV deals with the development and testing of plans. Chapters V and VI discuss at length the analysis and recommendations distilled from the planning process. Finally, Chapter VII is concerned with the continuing process that updates comprehensive transportation planning for the region.

SCOPE

The eastern Massachusetts region comprises 152 cities and towns and 2,300 square miles, populated by 3.5 million people. The region consists of the Boston, Brockton, Lowell, and Lawrence-Haverhill metropolitan areas; portions of the Worcester, Providence-Pawtucket, and Fitchburg-Leominster metropolitan areas; and 48 additional towns.

This report on transportation planning includes description and analysis of highway and transit networks within the region. As described in subsequent chapters, these networks were developed from an inventory of data collected for the base year 1963 and forecast to the future year 1990. The report recommends a plan for specific transportation network improvements and the staging of required projects, provides cost estimates, and discusses the implications of the plan.

OBJECTIVE

The primary objective of the planning work of this project has been the formulation of a comprehensive regional development plan, including a comprehensive transportation plan. This plan was developed from the analysis and evaluation of several alternative land use and transportation plans. These plans were based upon the collection, analysis, and projection of traffic, land use, economic, and population data and the evaluation of the interrelationships between this data and the transportation networks.

The transportation planning process provides the information necessary for making recommendations regarding when and where improvements should be made in the transportation system to satisfy travel demands and promote land development patterns that are in keeping with community goals and objectives. The Eastern Massachusetts Regional Planning Project had adopted a set of regional goals, objectives, and policy recommendations. These recommendations, prepared by MAPC in cooperation with EMRPP, are described in *Guides for Progress: Development Opportunities for Metropolitan Boston.*

As stated in *Guides for Progress,* goals are ends toward which programs and actions may be directed. Objectives also are ends, but they represent more detailed guides by which the fundamental goals may be accomplished. Policies provide direction for the development of specific programs and projects.

Transportation goals, objectives, and policies, which are designed to support and further the regional development goals described in *Guides for Progress,* are outlined below. During the continuing planning process, the goals statement will be subject to periodic review and refinement. However, it is the intent of the participating agencies to put the goal statement immediately to use in evaluating future projects.

TRANSPORTATION GOALS, OBJECTIVES, AND POLICIES

Economic Welfare

GOAL

To promote the economic well-being of all citizens.

OBJECTIVES

1. To assist in the enhancement of the competitive economic position of the eastern Massachusetts region in relation to the national economy.

2. To aid in the realization of equal opportunities for the full employment of all those willing and able to work.

3. To promote the advantageous geographic distribution of employment and commercial shopping centers throughout the region.

POLICIES

1. Provide and improve access to the widest possible range of job locations from the residences of all those capable of working.

2. Design and build transportation improvements in a manner that will promote the rational distribution of employment and shopping centers throughout the region.

3. Encourage the conservation and modernization of older industrial and commercial areas throughout the region by maintaining and improving transportation access.

4. Coordinate housing, renewal, and economic development policies with transportation facilities development.

5. Avoid community disruption to the maximum extent possible in the construction of transportation improvements and provide adequate relocation payments and services to residents and businesses that are adversely affected.

6. Promote increased tourism by making regional attractions accessible and by conserving and enhancing regional attractions through harmonious design of transportation facilities.

7. Promote, through appropriate transportation improvements, the expansion of the region's major institutions serving teaching, research, health, and economic welfare needs.

8. Improve the cargo handling capabilities of airports and seaports by improving access to them.

9. Encourage the retention and improvement of strategic rail freight facilities and associated terminal areas by providing the required access.

10. Provide highway facilities to handle the requirements of heavy trucking.

Human Resource Development

GOAL

To encourage the fullest development of the skills and abilities of all persons to permit them to participate more fully in employment and civic affairs and increase their enjoyment of leisure time.

OBJECTIVE

1. To give particular consideration to the needs of educational, health and welfare,

and public safety institutions and programs in the design and location of transportation facilities and the provision of transportation services.

POLICIES

1. Facilitate access to educational, cultural, and recreational facilities by youth and adults.
2. Facilitate access to health facilities and programs by all residents.
3. Facilitate access to programs designed to prevent delinquency and crime and to rehabilitate offenders.
4. Facilitate the development and enhancement of citizen participation in public and civic affairs.

The Quality of the Physical Environment

GOAL

To provide a transportation system that promotes a well-ordered and efficient physical environment, which has varied man-made and natural features and meets the esthetic, health, and recreation needs of all citizens.

OBJECTIVES

1. To enhance and conserve the natural beauty of the landscape.
2. To create attractive transportation elements in the physical environment that will provide diversity and interest and will orient the user.
3. To work toward the elimination of existing elements in the transportation system that are harmful and hazardous.

POLICIES

1. Coordinate new construction of transportation facilities and improvements to facilities and services with land development by continuing cooperative interagency planning and design.
2. Develop standards for spacing and locating expressway interchanges, based upon the developmental impact on the surrounding areas, the relationship of interchanges to transit facilities, and the ease of movement of automobiles and trucks.
3. Explore the development and adoption of standards to control noise, odor, heat, polution, and other possibly harmful effects of transportation facilities.
4. Coordinate the location of regional recreation areas so that no household will have to travel more than 30 minutes to reach a regional facility.
5. Design and locate transportation facilities to preserve unique natural areas and historic sites.
6. Select, preserve, or develop scenic views from roadways and transit lines, wherever possible, and avoid transportation system infringement upon open space and recreation areas.

Housing Opportunity and Choice

GOAL

To support the regional development goal of a safe and comfortable dwelling unit and suitable environment for daily living for every resident of the region.

OBJECTIVES

1. To provide a transportation system which encourages a range of densities, housing types, and prices within neighborhoods and communities.
2. To provide a transportation system which widens the choice of housing types and locations for all income, age, and ethnic groups.

POLICIES

1. Encourage zoning and other local development policy adjustments that further the stated housing goals and objectives.
2. Encourage maximum use by all communities of federal and state programs to improve the quality of housing, existing neighborhoods, and newly developing residential areas in coordination with the provision of transportation facilities and services.

Transportation System Design

GOAL

To provide for the safe, convenient travel of the public by means of an integrated transportation system which furthers regional economic, human resource, housing, and environmental development goals while making maximum use of existing resources.

OBJECTIVES

1. To develop a transportation system which will make the most effective use of all modes of transportation to serve the overall needs of the region.
2. To encourage continued effective use of the existing transportation system and add new elements to the system which clearly advance the region's development goals and objectives.
3. To make improvements to the existing transportation system which reduce economic losses to the user.
4. To maintain flexibility to the extent possible to permit introduction of technological advances into the system.

POLICIES

1. Encourage system continuity in the planning and programming of transportation projects.
2. Establish policies contributing to the integrated administration, planning, design, construction, maintenance, and improvement of highway facilities and services.
3. Encourage the definition of transportation planning districts to be geographically coincident with regional planning districts.
4. Continue cooperative formal interagency working relationships between functional transportation agencies and state, regional, and local agencies with planning and programming responsibilities in matters of transportation system planning and design.
5. Seek maximum equitable federal participation in improvement projects for all modes of transportation.
6. Seek greater percentage contribution from federal funds for transit projects.

7. Finance the state and state-aided highway system from the Highway Fund.

8. Adjust the income to the Highway Fund to meet the proper service and safety standards of an adequate regional highway system consistent with overall state needs.

9. Adjust the income to the Highway Fund in proportion to highway usage by various types and classes of vehicles.

10. Complete the interstate highway system and other major links by 1975.

11. Use available funds as soon as possible to complete the high-priority elements of the 1966 *Program for Mass Transportation.*

12. Encourage highway improvements that support transit.

13. Extend rapid transit lines to the point where terminals would be served by adequate highways.

14. Encourage transfer of riders from automobiles to transit at outer terminals by the provision of adequate parking and good transit services.

15. Give priority to mass transportation improvements serving radial movements into the regional core and distribution of people within the regional core.

16. Use railroad rights-of-way for rapid transit lines to the maximum extent possible.

17. Preserve existing commuter railroad service until adequate substitute transit service can be provided.

18. Acquire through public purchase and/or public control all railroad rights-of-way not needed for freight handling by private carriers to assure that the rights-of-way are available for transportation and utility purposes.

19. Develop a parking rate structure and system of parking facilities for Boston proper designed to increase the proportion of transit trips, especially during peak periods.

20. Encourage the establishment of a state program of financial assistance to local communities for the provision of off-street parking facilities associated with the increased use of transit and the improvement of traffic flow on major arterials.

21. Give high priority in the 1968-1975 period to increasing arterial traffic flows through the application of advanced traffic controls and monitoring devices and the elimination to the maximum extent of on-street parking that interferes with the orderly flow of traffic.

22. Give maximum emphasis between 1975 and 1990, through greater federal and state aid programs, to the improvement of arterials to acceptable standards of functional service.

23. Develop an integrated regional feeder bus system.

24. Initiate an integrated system of rapid bus service into the regional core and to major subcenters or to corridor rail rapid transit stations.

25. Encourage adequate regional core bus terminal facilities and the development of reserved bus lanes and exclusive bus rights-of-way where appropriate.

26. Encourage the development of parking facilities at highway interchanges to facilitate car pooling where appropriate.

27. Encourage the provision of the necessary legislative, administrative, and fiscal resources for undertaking joint development of multiple-use projects adjacent to or on air rights over highway and transit facilities.

28. Plan, design, test, and implement the most effective ideas and techniques in transportation safety.

29. Foster demonstration projects to determine the advisability and feasibility of improving transportation service and operation.

30. Encourage the undertaking of a continuing program of research on new transportation technology.

31. Support and encourage the continued development and use of the Transportation Planning Center for the coordination of the continuing transportation planning process.

III. BASIC PLANNING STUDIES

Transportation facilities are planned and built to carry people and goods. To plan for future facilities, a thorough knowledge of economic, land use, and transportation developments and their interrelationships is vital. The major steps of the urban transportation planning process are illustrated in Figure 6. This complex process is reduced to a logical sequence of technical elements by asking relevant questions:

- Population and economic studies: What will be the magnitude of the activities?
- Land use studies: Where will the activities be located?
- Generation: How many trips will these activities generate?
- Distribution: Where will these trips go?
- Modal split: What percent will use mass transportation?
- Assignment: Which routes will these trips take?
- System evaluation: What is the best transportation system?

To gain the information necessary to answer these questions, a number of basic planning studies were undertaken in eastern Massachusetts. All basic data was published as soon as it was available in finished form. The data is not reprinted in this report, but is available in separate reports (see the bibliography in Appendix B). The reports and data are kept on file in the library of the Transportation Planning Center maintained by the Department of Public Works in Boston.

To facilitate efficient processing and analysis of this travel information, each piece of data was related to a specific "traffic zone." Traffic zones are small fragments of the whole area, which are defined along neighborhood, census tract, and other boundaries for ease of identification, comparison, and analysis (see Figure 7). For the purpose of developing a transportation plan, the planning area was divided into 626 traffic zones and approximately 1,800 subzones.

The planning studies were conducted by the EMRPP staff or by consulting engineering firms whose work was monitored by the project staff. These studies are briefly covered in the following sections of this chapter. For a detailed discussion, see the numbered publications in Appendix B. A glossary of technical terms is given in Appendix C.

The major studies included:

- Comprehensive Traffic and Transportation Inventory (2)
- Comprehensive Land Use Inventory (6)
- Economic Base and Population Study (5)
- Traffic Forecasting (15)
- The Interim Travel Forecast to 1990 (7)
- Distribution of Land Use Activities (The EMPIRIC Land Use Forecasting Model) (8,9)
- Forecasting Trip Ends (15,22)
- Distribution of Trip Ends (The Gravity Model) (15,20)
- Modal Split (The Division between Private Auto and Transit Travel) (15,21)
- Traffic Assignment to the Network (15,19)
- Other Planning Studies (1,4,10-12,16)

ELEMENTS OF THE STUDY

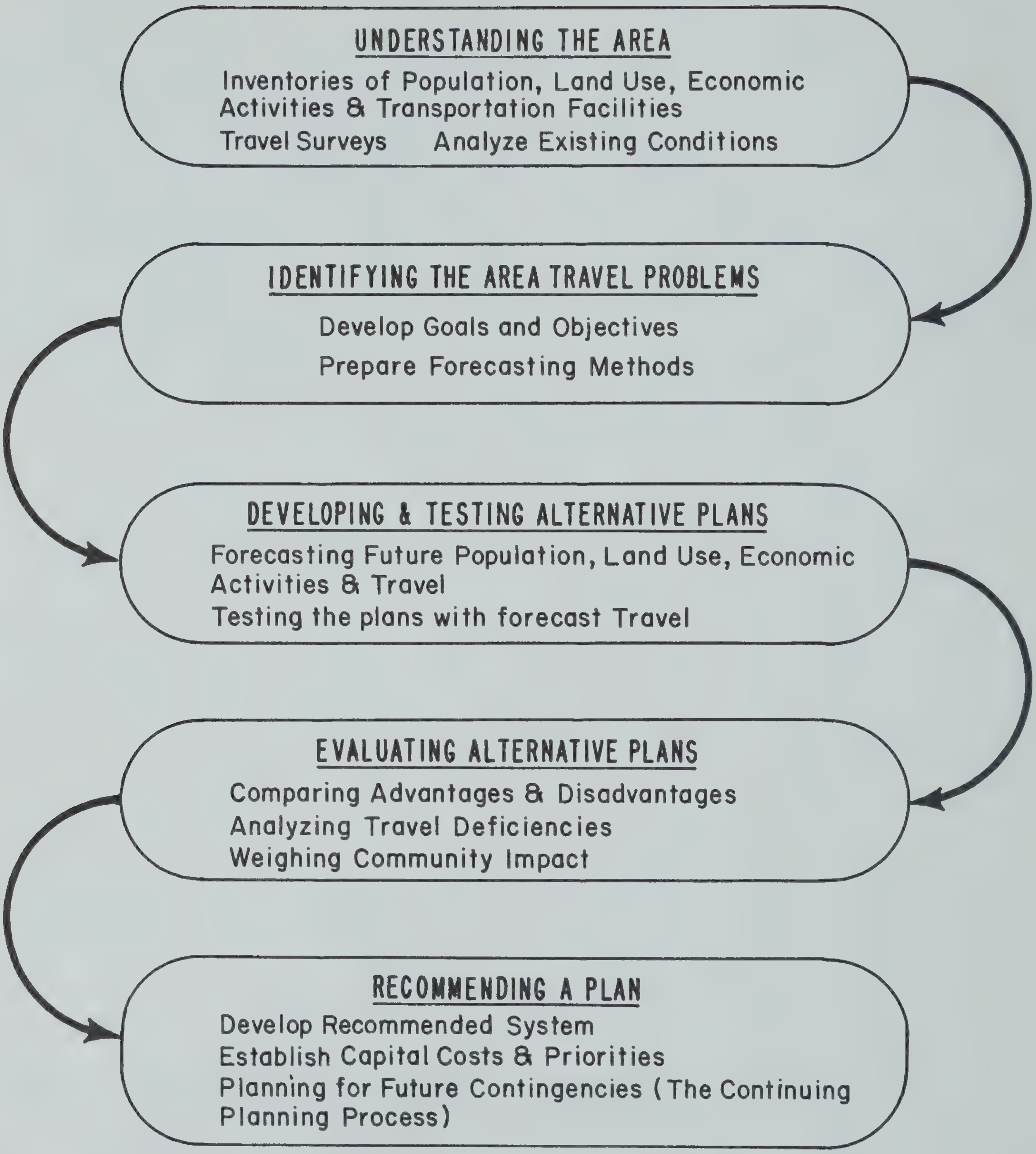
UNDERSTANDING THE AREA
Inventories of Population, Land Use, Economic Activities & Transportation Facilities
Travel Surveys
Analyze Existing Conditions
IDENTIFYING THE AREA TRAVEL PROBLEMS
Develop Goals and Objectives
Prepare Forecasting Methods
DEVELOPING & TESTING ALTERNATIVE PLANS
Forecasting Future Population, Land Use, Economic Activities & Travel
Testing the plans with forecast Travel
EVALUATING ALTERNATIVE PLANS
Comparing Advantages & Disadvantages
Analyzing Travel Deficiencies
Weighing Community Impact
RECOMMENDING A PLAN
Develop Recommended System
Establish Capital Costs & Priorities
Planning for Future Contingencies (The Continuing Planning Process)

FIGURE 6

URBAN TRANSPORTATION PLANNING FORECASTING PROCESS

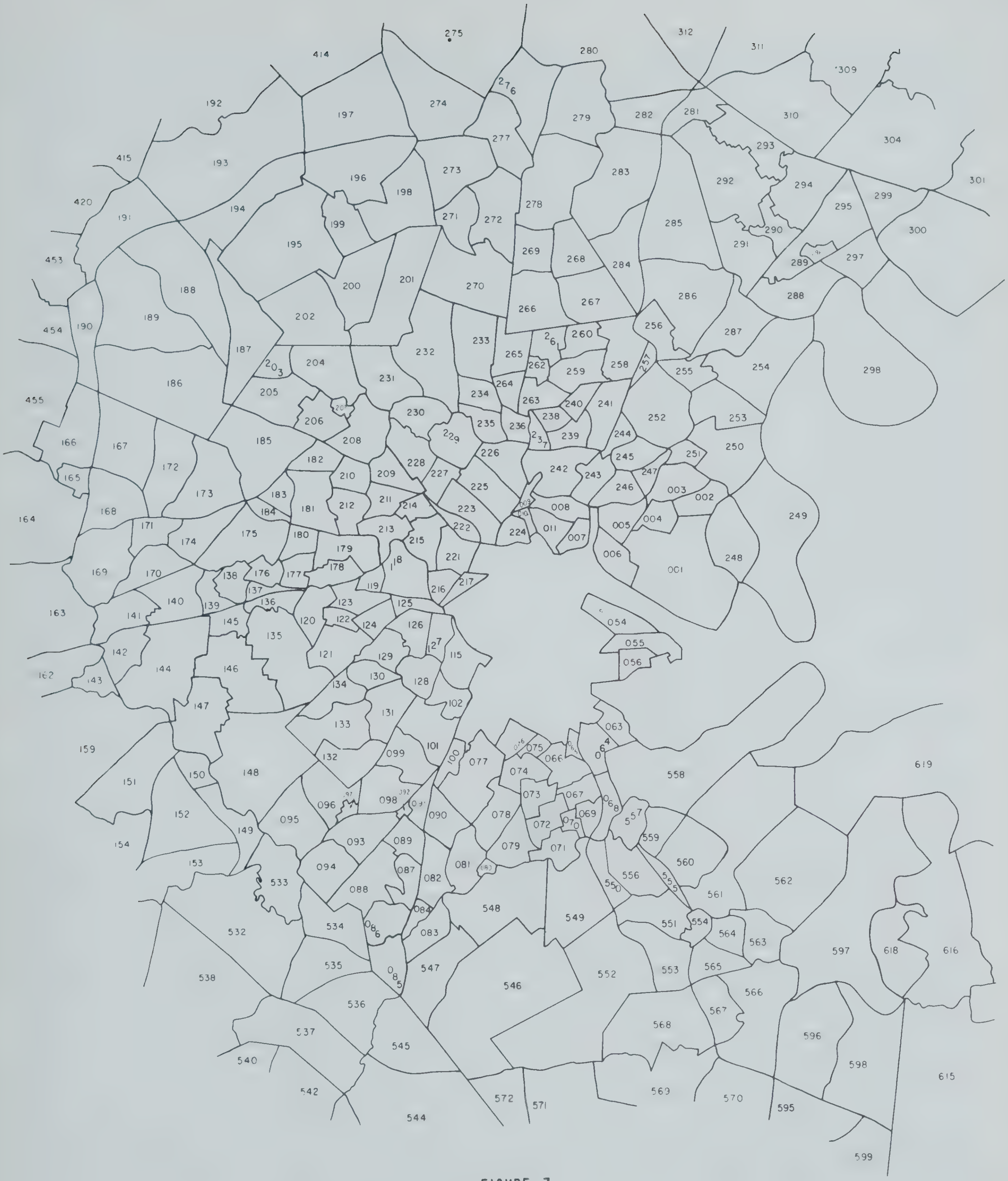

FIGURE 7

TYPICAL EMRPP TRAFFIC ZONE MAP
(PARTIAL AREA WITHIN ROUTE 128)

COMPREHENSIVE TRAFFIC AND TRANSPORTATION INVENTORY (2)

This inventory consisted of five surveys:

- Transportation Facilities Inventory
- Home Interview Survey
- Truck and Taxi Survey
- External Cordon Survey
- Transit Postcard Survey

The Transportation Facilities Inventory

This inventory included detailed information about the characteristics and usage of nearly 4,000 miles of major highways and principal streets within the study area, supported by an extensive compilation of data on the extent, service, and use of the public and privately owned mass transportation systems in the region. The inventory was used as a basis for developing and coding the 1963 highway and transit networks for use in the computer simulation and analysis.

The Home Interview Survey

This survey obtained comprehensive data on travel within the region, including the numbers of trips made, the various travel modes, the purposes of the trips, and the origins and destinations of trips, as well as socioeconomic characteristics of households. Interviews were completed at 18,000 homes located within Route 128 and at 21,000 homes outside Route 128.

The Truck and Taxi Survey

Data was collected for selected samples of trucks and taxis registered in the study area. The truck survey involved about 9,500 vehicles and the taxi survey 370 vehicles, or about 10 percent of the trucks and taxis in the region.

The External Cordon Survey

This survey consisted of interviews of about 145,000 motorists who crossed the study boundary during the summer of 1963. This number represented about 40 percent of all vehicles crossing the external cordon on an average summer weekday at the 102 points where traffic enters and leaves the region.

The Transit Postcard Survey

Users of public transportation facilities were surveyed; over 100,000 passengers answered questionnaires concerning their inbound transit trips.

COMPREHENSIVE LAND USE INVENTORY (6)

This inventory was carried out for the full 2,300-square-mile region. It consisted of the following phases:

- Aerial Photography
- Classification of Land Use
- Computation of Areas
- Location of Land Use Areas
- Summary of Data

Aerial Photography

The aerial photographs employed were obtained from flights made in the spring of 1963 and from the U.S. Department of Agriculture photographs of 1952 (see Figure 8).

A total of 559 photo enlargements of the 1963 aerials were made at a scale of 1 inch = 300 feet for rural areas and 800 enlargements at a scale of 1 inch = 150 feet for urban areas. Up-to-date base maps were prepared at U.S. Coast and Geodetic Survey scale (1 inch = 2,000 feet) for the full study area, together with aerial photo mosaics at the same scale.

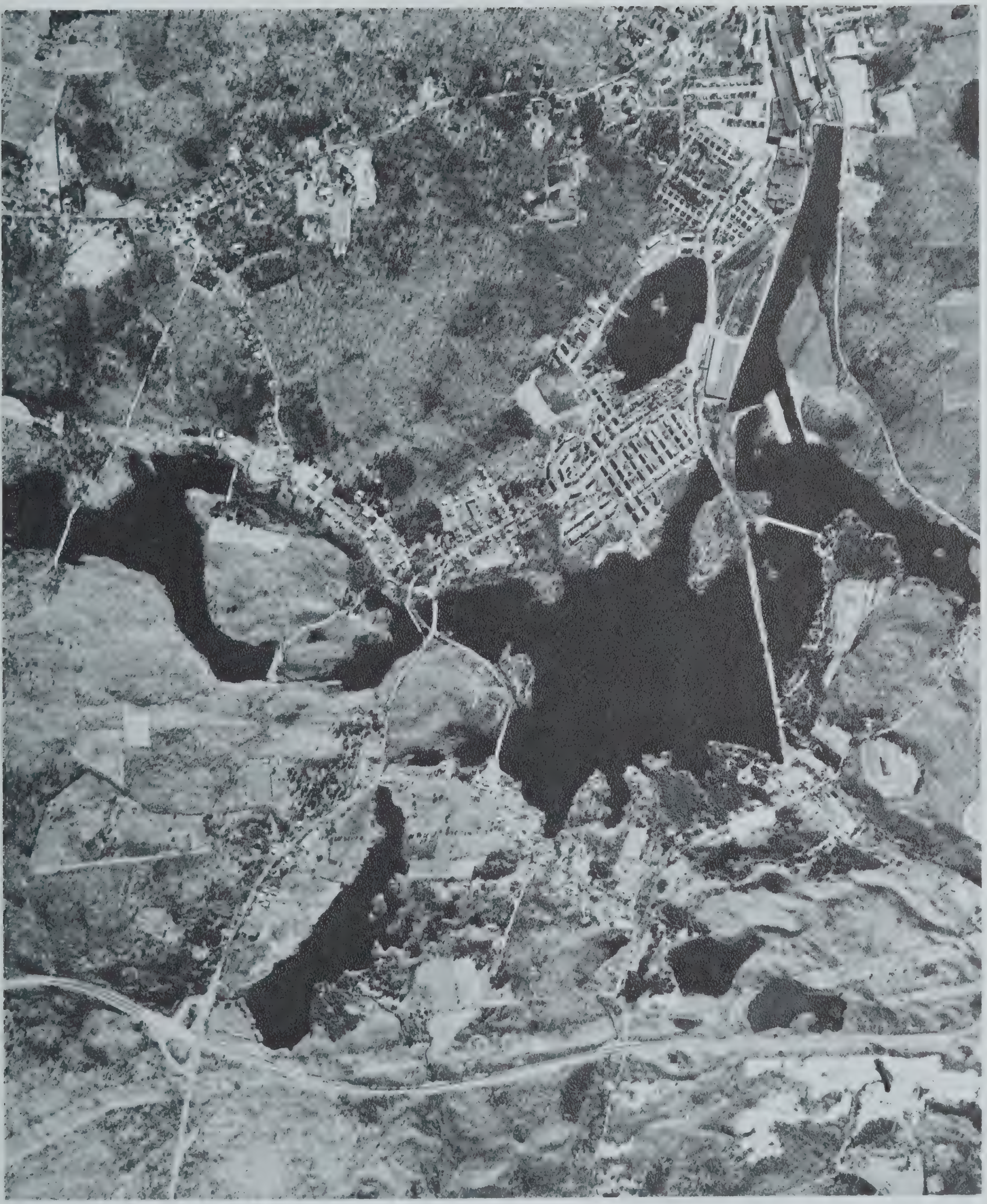

FIGURE 8

TYPICAL AERIAL PHOTOGRAPH
(SECTION OF EMRPP)

Classification of Land Use

Land use was classified into 63 categories for detailed analysis and later summarized into broader groupings. Photo interpretation was used almost exclusively in the rural areas. Field inventories supplemented photo interpretation in the urban areas to establish the classification and relative intensity of different uses.

After the land uses on the 1963 aerial photos were classified, the photo interpreter examined the corresponding 1952 aerials for changes. Any changes from the 1952 land use were noted. In this manner, accurate measures of the changes in land use were obtained for the 11-year period. These measures of change were helpful in forming the statistical basis to forecast future use in the EMPIRIC Land Use Distribution Model described later in this chapter.

Computation of Areas

Computer programs calculated the area of each land use within each zone. A boundary corner coordinate system was used to compute the areas.

Location of Land Use Areas

The location of each homogeneous land use area was established by the Massachusetts coordinate system. These areas were also related to traffic zone numbers, town names, and other identifiers. The coordinates selected were located at the approximate center of activity in the land use areas.

Summary of Data

The data for all land uses was summarized into general categories needed for analysis and forecasting. Summaries were aggregated from the original 63 land use codes into systems of 10, 12, and 24 generalized codes. Further aggregation can be performed as needed. Summaries of specific data (for example, vacant land) were also used to help distribute land use activities, as discussed in a later section on the EMPIRIC Land Use Model.

ECONOMIC BASE AND POPULATION STUDY (5)

Planning for regional transportation and development required projections of:

- Employment by Industry
- Population, Labor Force, and Households
- Personal Income and Consumer Expenditures

Employment by Industry

To build a foundation for reasonable projections of future economic activity and employment, historical estimates for the region were prepared for gross regional product, employment, wages and salaries, personal income, and consumer expenditures. The forecasts were based on national and local markets, together with historical trends and the underlying reasons behind these trends.

Population, Labor Force, and Households

The analysis of past trends and projections of future population growth and characteristics were based on national figures from the U.S. Bureau of the Census and state and local data from the Massachusetts Department of Commerce and Development and other sources.

Size, location, age, sex, education, employment, and other characteristics of the population were examined and projected to determine the future needs for various types of housing, schools, health facilities, recreation facilities, transportation facilities, and other items.

Personal Income and Consumer Expenditures

Personal income and consumer expenditures were also analyzed and projected. Expenditures related to transportation received particular attention.

This data for the base year 1963 was taken from the Census, the Department of Employment Security records, and other sources. The projected increase in incomes will result in increased auto ownership; therefore, the travel projections, which are a major determinant of future highway and transit needs, were also increased.

TRAVEL FORECASTING (15)

The original travel forecasting concept used in the 1920's was a traffic counting procedure; statistical techniques were applied to expand these counts to reflect an average daily traffic volume. Traffic counts in themselves, however, could not be used to estimate or predict the actual movement of traffic. The statistics merely indicate the usage of existing facilities without regard to the basic travel desires of travelers between various sections of the area.

To provide a more comprehensive source of information on the transportation requirements of an urban area, the origin-destination survey was developed in the late 1930's. This method, which uses various forms of roadside, home, truck, and taxi interviews, provides reliable data on existing traffic movements and the motivating factors that influence travel desires. Nevertheless, traffic engineers soon recognized the shortcomings of transportation facilities plans that were based only on existing origin-destination patterns. The shortcomings became particularly apparent after World War II, when the facilities that had been planned from existing patterns proved inadequate to handle the rapid increase in auto ownership and travel in urban areas.

The third major step in this evolutionary process came with the development of a mathematical "growth factor" technique to expand existing travel patterns (which were obtained with origin-destination surveys) to reflect anticipated future development of an area. While the growth factor technique of forecasting origin-destination changes represented a significant advance in the field of urban traffic analysis, it had many serious limitations. For example, it could not estimate future travel patterns resulting from major changes in land use, such as those that might occur with construction of a new shopping center or through urban development.

The present method of traffic forecasting came about in the late 1950's, with the development of traffic models. These mathematical formulas or simulation techniques aim at overcoming the deficiencies of the previous growth factor method. Subsequent sections of this chapter describe their use for this project.

THE INTERIM TRAVEL FORECAST (7)

There is no shortcut to the establishment of a comprehensive transportation plan to meet future needs. The period required to organize the project, carry out the studies, and make the final recommendations may be six or seven years in a major metropolitan region. While long-range plans are being developed, the planning, design, and construction of transportation facilities must continue.

An interim travel forecast was necessary for the design of those facilities for which commitments had been made and decisions were needed. A firm of planning and transportation consultants, working in close cooperation with the project staff, performed the preparatory analysis and the interim forecast for the EMRPP. To make this forecast, the following major work elements were completed:

- analysis of data from the travel inventories;
- organization of data for input to the traffic model;
- preparation of the networks for use by the model;
- development of relationships between socioeconomic characteristics (i.e., income, car ownership, type of dwelling, etc.) and rates of trip making;

- preparation of a trip distribution model;
- assignment of present and future travel volumes to the transportation network.

The interim travel forecast served well the immediate objective of responding to the needs of the highway designers. In addition, several of the new techniques had not been previously applied to such a large region, and the resulting experience provided important insights and led to the later improved methods of comprehensive planning for an area of such magnitude. This experience was invaluable to the ultimate formulation and testing of the plans that led to the project's final recommendations.

DISTRIBUTION OF LAND USE ACTIVITIES (THE EMPIRIC LAND USE FORECASTING MODEL) (8,9)

To design transportation facilities that will serve the region effectively in the future, forecasts of traffic flows (i.e., trips produced at an origin and attracted to a destination) are required.

From the inventory of existing trips, base year trip rates were developed by purpose. These trips are the result of the travel needs of several socioeconomic groupings (e.g., population by subgroups, employment by subgroups, etc.). From detailed studies of historical trends, projections of socioeconomic and land use activities for the entire eastern Massachusetts region were made to the year 1990. To be of use in the traffic forecasting process, these regional projections had to be distributed to the individual traffic zones.

In early 1963, the EMRPP was unaware of any existing land use distributing technique that was sufficiently flexible and reliable to satisfy the project's needs. A contract was made with a consulting firm, monitored by the project staff, to develop such a technique. For the project and the profession, this was an important change from intuitive estimating to large-scale regional planning.

Traditionally, land use activity had been distributed by rules of thumb and the planner's personal assessment or insight. However, the principles used for these allocations were usually oversimplifications of the real, complex locational preferences of people.

About 1950, the first simple land use models were developed, mainly in connection with large urban transportation studies. Early attempts at developing land use models were based on separate models or equations to forecast the residential, industrial, and commercial activities being distributed. Use of these models still required judgment about which activities should be located first, because all activities competed for the same available land, and the location of one activity depended on the location of another. The normal sequence of activity location was industrial, residential, and commercial.

The EMPIRIC Land Use Model, developed for the EMRPP starting in 1963, does not require a presupposition about which activity must be located first. It uses a formal mathematical framework that recognizes the simultaneous interacting nature of metropolitan growth. The model consists of a set of simultaneous equations, programmed for a computer, which provide zonal distribution of population, employment, automobile ownership, family income, etc. The equations were derived from the measures of actual zonal changes in these urban activities between 1950 and 1963. These equations are sensitive to many of the policies included as elements of the comprehensive plan, particularly transportation policies.

Inputs to the model are the total values of forecast regional population, employment, estimates of open space, etc. Other types of information required by the EMPIRIC Model are water and sewer facilities, present and future year travel times, local zoning restrictions, and the effects of urban renewal projects.

The EMPIRIC Model is a computer technique that distributes regional totals of urban activities. This technique is undoubtedly one of the most advanced and reliable methods developed to date. The results are used as input to the traffic forecasting techniques being applied to the region. The technique is sufficiently sensitive that the model is used as a planning tool to test alternative development plans; i.e., to measure the impacts on development patterns of alternative sets of public policies.

FORECASTING TRIP ENDS (15,22)

Trip generation procedures have greatly contributed to a better understanding of the urban transportation problem. Trip generation is the term applied to the estimating technique used to determine the number of trips "produced" at an origin (a residence, for example) and "attracted" to a destination (such as a place of employment). This technique generally assumes that the relationship between the socioeconomic data and trip ends for the base year and the forecast year remains constant.

Trip production is related to household income, family structure, automobile ownership, etc. Trip attraction is related to items such as the number and types of jobs within the employment area.

Current and forecast urban traffic patterns are a function of:

- the pattern of land use in an area, including the location and intensity of use;
- the various social and economic characteristics of the population of an area; and
- the type and extent of the transportation facilities available in an area.

From the data of the base year survey, zonal trips and socioeconomic activities are related to establish trip rates (trips per dwelling unit) for various purposes. With the projections of the socioeconomic activities made for the future year and distributed to the zones by the EMPIRIC Model, a simple factoring process can determine the trip ends for the future year. This was the actual method used to estimate the home-based* trip ends for the systems tested.

To determine future non-home-based trip ends, the estimates were drawn from a more complex set of land use activity variables. These variables are initially chosen by a theoretical analysis that determines the most significant elements in the trip-making pattern. For example, the number of shopping trips is related closely to retail employment, while the number of trips attracted to work is related to overall employment. For the base year, mathematical equations are developed that relate trips for various purposes to employment categories and other elements, such as school enrollment. The purposes considered are work, personal business and shopping, social and recreational, school, and non-home-based trips. The zonal forecasts of these variables (derived from the EMPIRIC Model) are then used in the equations to forecast future trip ends.

The next step is to connect these trip ends. The most widely used technique for distributing trips is the "gravity model," which was used in this study.

DISTRIBUTION OF TRIP ENDS (THE GRAVITY MODEL) (15,20)

The travel forecasting procedures discussed so far have been concerned with estimating future trip ends (that is, trips produced or attracted in each zone). By distributing these trips, origins and destinations are linked to form regional travel patterns.

*Trips that start or end at home.

The gravity model is a synthetic process for distributing trips. The name is derived from the fact that trips are distributed by a formula that resembles Newton's law of gravitational attraction. Newton's law states that objects attract each other with a force that is directly proportional to the product of the masses of the objects and inversely proportional to the square of the distance between them. Similarly, the gravity model formula distributes trips in direct proportion to the drawing power of an area, which is measured by trip attractions (analogous to the mass of an object in Newton's formula), and in inverse proportion to a function of the time separation between the areas.

Thus, the gravity model states in mathematical terms that trips between the zones (i-j) are directly proportional to the number of trips generated in a zone (i) and the number of trips attracted to a zone (j), and are inversely proportional to a function of the travel time between the zones (i-j).

Both highway and transit interzonal travel times were included in the project's model. The model used travel time, rather than travel distance, to represent the spatial separation between zones. Approximately 391,000 individual zone-to-zone travel times are required for the distribution of transit trips and 529,000 for highway trips. The magnitude of these numbers makes it obvious that these travel time values must be calculated and manipulated by high-speed digital computers. The calculations are carried out using a transportation network coded in a mathematical form compatible with the requirements of the computer.

The travel time function of the gravity model was first calibrated with base year survey data before distributing forecast trip ends. The project model is based on five trip purposes (work, personal business and shopping, social and recreational, school, and non-home-based trips). Each purpose is calculated separately and the results totaled to obtain person travel for the region. The next step takes the distribution of total person travel and separates it into transit and highway trips.

MODAL SPLIT (THE DIVISION BETWEEN PRIVATE AUTO AND TRANSIT TRAVEL) (15,21)

The process of dividing total travel between any two zones into private auto and transit travel is based on the observed tendencies of people in certain income and auto ownership categories to use transit, depending on its availability and service. Future travel in the region will be by automobile, trucks, and taxis, and on transit (bus, railway, and rapid transit vehicles). The actual split between auto and transit is based on calibrated relationships derived in several major cities, which were checked against Boston data. The "modal split," which is the percent transit of total trips between any two zones, is a function of five factors: relative travel time, relative travel cost, the economic status of the trip maker, relative convenience, and trip purpose.

The modal split relationships were applied to total person movements to obtain the magnitude of the transit trips. Total transit trips were then subtracted from total person trips, resulting in interzonal auto person trips.

Person trips by auto were then factored by auto occupancy rates to calculate auto vehicle trips. Estimates of truck and taxi trips were made in much the same way as person trips and, along with an estimate of travel from outside the region, were added to the auto vehicle trips.

All forecast trips were then assigned to the networks to produce traffic estimates for individual routes and facilities.

TRAFFIC ASSIGNMENT TO THE NETWORK (15,19)

Traffic assignment is one of the most important and complex phases of the transportation planning process. It provides the engineer with a systematic and reproducible technique that enables him to predict the probable traffic loads on each link of a transportation network. The economic and operational impact of various transportation system designs can be compared and evaluated, and after analysis, the results may be utilized to prescribe changes that would overcome deficiencies and improve the system.

Traffic assignment is the process of allocating a given set of trip interchanges to a specific transportation system. The process is used to estimate traffic on various links of a system for a future year or for the simulation of present conditions. For a future year, a forecast of area-to-area trips by mode is input to the process. The output is an estimate of the traffic volumes on each link of the system, by direction, complete with the directional turning movements at the intersections.

Traffic assignment for this project was accomplished by a "minimum path" technique known as the "all or nothing" method. The computer program assigns 100 percent of any particular interzonal movement to the minimum time path through the network. After the trips have been assigned from one zone to all other zones, the computer selects the next zone and repeats the process until all of the trips from all of the zones have been loaded onto the network.

The traffic assignment technique provides the necessary tools for testing alternate networks for adequacy. However, traffic assignment does not take the place of planning. It merely enables the planner to uncover the areas of greatest need and to test the consequences of various possible plans.

OTHER PLANNING STUDIES

These studies included:

- Inventory of Water and Sewer Facilities (11)
- Open Space and Recreation Study (4)
- Guide for Improvements in Traffic Performance (12)
- Comparison of Vehicular Transit Systems in the Greater Boston Area (1)
- Parking: A Regional View (16)
- Historic Sites (10)

An Inventory of Water and Sewer Facilities

A consultant inventoried water and sewer facilities under the direction of the staffs of the Metropolitan Area Planning Council and the Department of Commerce and Development. The inventory was used to develop information for input to the EMPIRIC Land Use Forecasting Model and to provide basic data for the region's 152 communities. This data is required to obtain water and sewer grants from the U.S. Department of Housing and Urban Development.

Open Space and Recreation Study

The MAPC conducted this study for the project. The study consisted of an inventory of existing sites, a summary of past plans, a landscape survey, the formulation of policy, and a series of design studies that would relate open space and transportation. The study provided information on alternative patterns of open space and recreational facilities to be used for forecasting and laid the groundwork for further development of open space concepts by the regional planning agencies.

Guide for Improvements in Traffic Performance

The project staff undertook a study of the problems of traffic engineering, aimed at investigating the methods by which communities could improve traffic performance on their arterial systems. This study suggests the techniques required to identify the critical areas of congestion; the recommended steps toward their relief, employing traffic engineering principles; and the necessity of assigning competent traffic engineering personnel to administer such efforts.

The future transportation system will include many of these arterials; thus, any increase of traffic will aggravate congestion problems, and solutions are mandatory. The increasingly heavy traffic on expressways in urban areas, together with the disruptive effects of major new construction, makes it doubly necessary to make the most efficient use of existing arterials. Relatively low-cost improvements can upgrade traffic operations and decrease congestion immensely. The TOPICS Program recently initiated by the Federal Government will provide welcome assistance in the efforts to solve these problems.

Comparison of Vehicular Transit Systems in the Greater Boston Area

A study under the direction of the MBTA examined recent developments in transit vehicles and systems and their applicability to the Boston area. This information provided a basis for the MBTA program that is incorporated into this project's recommendations.

Parking: A Regional View

This study analyzed parking, as measured by the origin and destination survey, in the more densely developed areas of the region. The study provided a means of forecasting the parking demand for areas of high activity.

Historic Sites

Historic sites are a legacy that cannot be replaced. An inventory was begun to locate them so that an "early warning system" might be devised to alert designers that a transportation facility or other project could intrude on a site. Alternatives could then be considered at an early stage of design. As additional transportation facilities are planned and built throughout the region, minimum disruption of historic sites should result.

Basic Studies Applied

The inventoried data of these basic planning studies and the methods described for projecting this information from the base year to some future year form the basis of regional development plans and the accompanying transportation plan development, to which the following chapters are devoted.

IV. TRANSPORTATION PLAN DEVELOPMENT

PURPOSE OF TRANSPORTATION PLAN DEVELOPMENT

The primary purpose of this transportation planning report is to provide specific recommendations for facilities needed, based on a regional overview. The recommendations are costed and their benefits analyzed. These costs and their related construction staging provide a capital improvement budget for regional highway and rapid transit projects.

The report fulfills the requirements of the Urban Mass Transportation Act of 1964 (18)* by providing recommendations for an officially coordinated urban transportation system. As a result of this planning, the eastern Massachusetts region will become eligible for two-thirds grants for mass transit projects, instead of the present one-half funding.

Also, the 1962 Federal Aid Highway Act (29) called for comprehensive transportation planning; this report fulfills that requirement as well. Therefore, the urban areas of the eastern Massachusetts region can continue to receive approval of the Secretary of Transportation for federally aided highway projects.

This report also provides information that will aid other agencies, public and private, in making decisions.

The relationship of transportation planning to the region's historical development and to regional development planning is brought out in the following sections of this chapter.

THE REGION'S HISTORICAL DEVELOPMENT

The eastern Massachusetts region is an older and more mature region than most of the nation's urbanized areas. The history of its urban settlement goes back almost 350 years. The communities that grew at several points along the Atlantic coastline and on river sites inland became commercial centers, with major activities of shipping and commerce, tanning, and textile production.

A proliferation of distinct neighborhoods and towns was the most significant aspect of the physical pattern of development. While Boston emerged in the 19th century as the dominant center of population and trade, manufacturing activity was widely dispersed throughout the region in a pattern that still exists. The strong traditions of local government autonomy that grew up in the localized manufacturing and commerce centers evolved into today's pattern of separate neighborhoods and many small towns and cities (see Figure 9). Towns tended to resist absorption into larger cities. Consequently, Boston is one of the smallest central cities of any major metropolitan area in the United States.

Despite this "multinucleated" pattern of growth, a radial pattern of highways and railroads converging on Boston linked the regional trade and distribution centers of production and consumption. As the region grew, the spaces between the individual centers were gradually filled in, with the major concentration of settlement and manufacturing activity occurring along the radials. This hub-and-spokes pattern is evident today.

While this growth of the region along radial corridors continues, neighborhood and town boundaries are no longer distinct. However, the pattern of local neighborhood identification and individual town governments has endured.

With the emerging dominance of auto and truck transportation since World War II, both residences and industry were freed from dependence on proximity to the regional core or to the fixed radial rail transportation channels. This mobility has influenced dispersal of activities along

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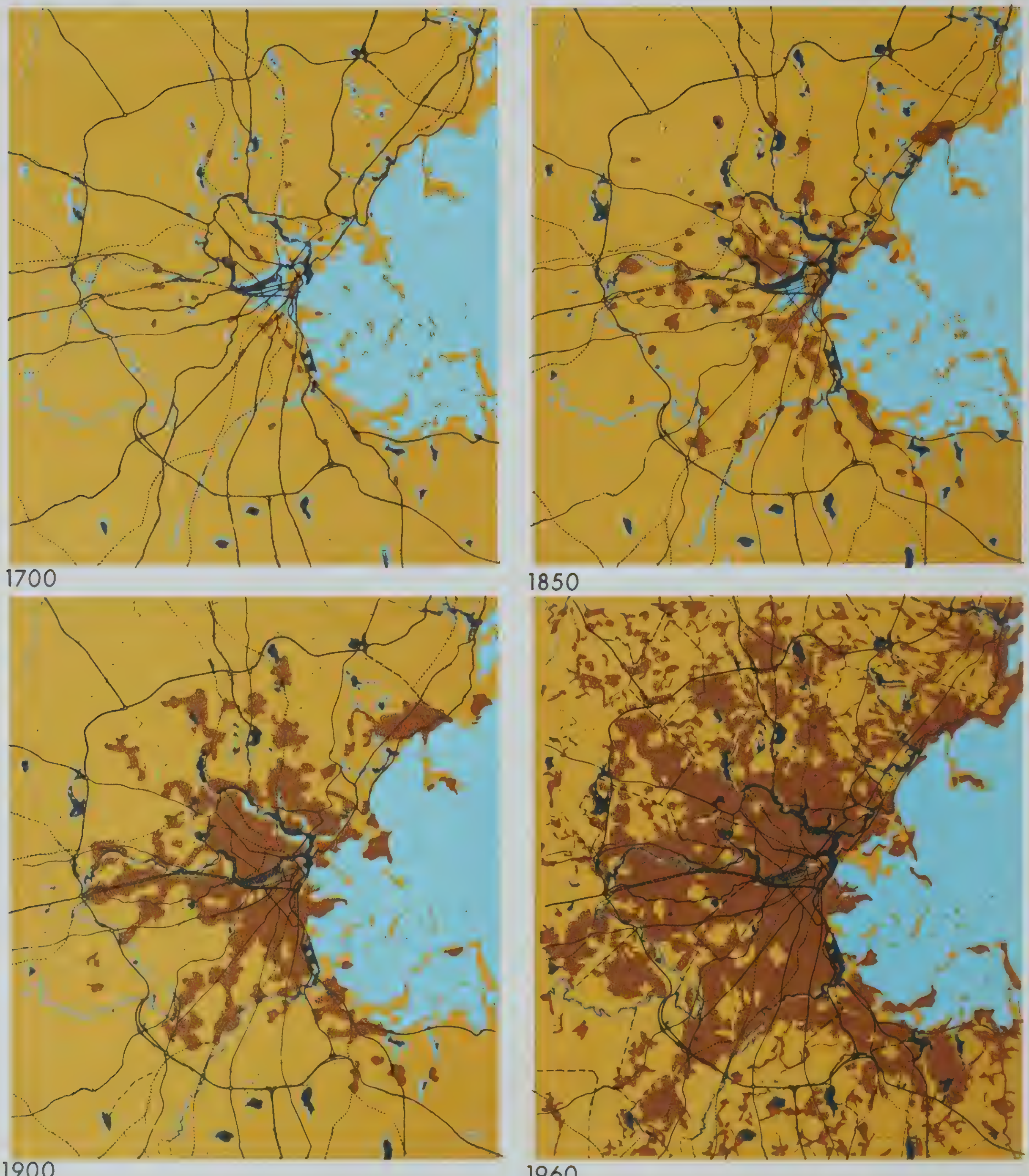
*Numbers in parentheses refer to the publications listed in Appendix B.



1700

1850

1900

1960

FIGURE 9

HISTORICAL PATTERN OF REGIONAL SETTLEMENT 1700 / 1960

COURTESY OF BOSTON REDEVELOPMENT AUTHORITY circumferential corridors. Route 128 typifies the new circumferential pattern, drawing industry to the periphery of the older central area while facilitating low-density residential development beyond it. This pattern encourages the early multinucleated development by creating new connections between areas without tying them to the regional core.

The three patterns of growth that this complex area has followed have resulted in today's "composite" structure. The eastern Massachusetts region's unique historic development continues to exert powerful pressures in the shaping of the regional pattern. The study of historic growth and development, therefore, can give some indication of what lies ahead.

REGIONAL DEVELOPMENT PLANNING

Transportation planning is an integral part of comprehensive regional planning and development. Regional development is based on several factors; the most important is the anticipated or planned future use of the land. Land use forecasting, therefore, occupies a critical role in the planmaking process.

Four alternative development plans, including land use forecasts, were developed for the eastern Massachusetts region by MAPC and DCD.* The MAPC description of the plans is given in Table 1. At the same time, four corresponding transportation networks to effect these growth plans were developed with DPW and MBTA. The regional plans and networks were named as follows:

- composite;
- radial corridor;
- controlled dispersal;
- multinucleated.

The four alternative patterns were evaluated to meet the region's future objectives and development goals.

SELECTION OF TWO REGIONAL PLANS

Detailed analysis of all four plans would have been too costly and time consuming. Therefore, the EMRPP developed criteria for comparing the relative general merits of the plans and then chose two for detailed analysis.

The best decisions are made on the basis of tangible, measurable facts. However, many of the factors involved in choosing regional plans escape measurement, such as the value of scenic features, historic sites, recreation areas, and the like. The preservation of these features obviously would be an objective of these plans. But measuring the attainment of such an objective is difficult, when the value of "scenery," for example, cannot be expressed in numerical terms. Still, all possible elements should be measured, because measurable facts allow the decision-makers to weight variables objectively in the selection process.

Table 2, originally prepared by MAPC, lists the measured variables and the objectives to which they are related. Examination of these lists provides an insight into the process used to select two plans for analysis. Table 3 summarizes the information in Table 2 and ranks the four plans.

In addition to the measured and rated items in these tables, other factors considered were feasibility, amount of government control necessary for implementation, and degree of conformity with the desires that people show by trends in purchasing homes, automobiles, vacation houses, etc. Based on these criteria and the judgment of the Project Technical Committee, the Composite Plan (Plan A) and the Controlled Dispersal Plan (Plan C) were chosen for detailed testing and analysis.

TRANSPORTATION PLAN TESTING

Sound engineering practice dictates that new transportation systems, like all new concepts, be

---

*For a detailed discussion of the development proposals, see the report, *Guides For Progress: Development Opportunities For Metropolitan Boston* (13), prepared for this project.

tested. Transportation system testing is accomplished through computer simulation of networks and travel, using the techniques described in Chapter III. Analysis of test results requires answers to certain questions; for example:

- Does the system suffer from congestion?
- How much will the system cost?
- Does it serve the demands well or does it make travel circuitous?
- Does it create parking problems?
- What are the land use and socioeconomic implications of the plans?

Only after questions like these are answered can recommendations be made concerning future transportation systems. The analysis of Plans A and C in Chapter V and the recommendations in Chapter VI answer such questions.

A. COMPOSITE PLAN

The composite plan is not amenable to broad summarization because it embraces features, objectives, and policies borrowed from each of the other alternatives. Its main characteristic is that individual sectors or subareas of the region are built around different alternatives, with subarea boundaries coordinated as necessary. For instance, one portion of the region, presently undeveloped, might be oriented toward controlled dispersal objectives, while another area, an existing suburb, might aim toward radial corridor or nucleated objectives. The composite plan represents a controlled combination, at different locations, of the other three alternatives described here.

B. RADIAL CORRIDOR PLAN

Salient Features

1. Most new urban development to be concentrated along five noncontiguous travel corridors radiating from the regional core to provide a choice of effective modes of travel.
2. Commercial and high-density residential areas to center on rapid transit stations.
3. Density of urban development within the corridors to diminish as the distance from the regional core increases.
4. Areas between the corridors to be relatively free of new urban development. These areas to be characterized by low-density residential, agricultural, and open space preserves.

Objectives

1. To encourage population and employment growth in the core to insure that Boston remains the cultural and economic hub of the region.
2. To insure that transit becomes economically more viable.
3. To provide for rapid mobility to and from the core and within the corridors.
4. To provide easy access to large major public open space and recreational facilities.
5. To retain tracts of relatively undeveloped land which may be required for development beyond 1990.
6. To provide a greater number of job opportunities for employment of low-income groups that are convenient to low-income residential areas.

B. RADIAL CORRIDOR PLAN (Cont.)

Strategic Implementation Policies

1. Highways: Expressways paralleling transit to be built in Western and Southwest Corridors. Arterial upgrading within corridor areas to emphasize circulation within those areas. Arterials to be built or upgraded in the noncorridor areas only where access to selected development is required (e.g., major recreational area, historic site, or existing town center).
2. Transit: Major rapid transit extensions to be built in five corridors along existing railroad rights-of-way. Facilities in the core to be upgraded to accommodate a substantially larger system, more rolling stock, and more frequent service.
3. Sewer and Water Facilities: MDC District to be expanded into the corridors; noncorridors to be excluded from MDC District. Financing from state and federal sources to be used for municipal systems only in corridor areas. Sewage treatment plants to be required for all municipalities but state financial assistance provided only for those in corridors. Use of private wells and septic tanks to be prohibited within industrial, commercial, or residential areas that are moderately to intensively developed.
4. Open Space: State to acquire key open space areas to control the character of development. State to purchase development rights on existing agricultural land. More federal and state forest, game, and wildlife preserves to be established in noncorridor areas.
5. Renewal: Major renewal and rehabilitation to be conducted in the core area, especially for commercial development.
6. Zoning: Alternatives to existing municipal zoning to allow for high-density and varied land use development in corridors and restrict land use density severely in the noncorridors.
7. Planning: Extensive new "master planning" to be conducted at the municipal level for towns and cities in the corridors.
8. Parking: On-street parking in the core to be discouraged.

C. CONTROLLED DISPERSAL PLAN

Salient Features

1. New urban development to take place on currently undeveloped land.
2. Single-family detached dwelling units or relatively low-density development to account for most new residential construction.
3. Small dispersed shopping centers to be built.
4. Dispersed industrial parks to be developed.
5. Open space and recreation system to be local in scale and developed for intensive use.

Objectives

1. To provide more privacy and family living space.
2. To provide more home ownership.
3. To provide greater sharing of growth among municipalities.
4. To emphasize individual mobility for all types of trips, resulting in more nearly uniform automobile accessibility to activities throughout the region.
5. To provide high accessibility from home to open space and recreation areas.
6. To lessen land development problems for local government.

Strategic Implementation Policies

1. Highways: Planned state and interstate expressway system to be completed. A grid of arterials to be developed to serve areas between expressways.
2. Transit: Beyond MBTA Master Plan for 1975, no new transit extensions to be built.
3. Sewer and Water Facilities: Selected municipalities to develop piped systems and treatment plants. In lower density areas, wells and septic tanks to service new development.
4. Open Space: Acquisition and development of small-scale, scattered, highly accessible recreation areas to be emphasized. Acquisition and development of large-scale regional park and recreation facilities to be less extensive.
5. Zoning: Selected municipalities to be encouraged to change to large-lot zoning while providing for cluster development with large open recreational areas.
6. Official Map and Subdivision Ordinances: Requires firm measures to insure the quality of residential and commercial development to be initiated by municipal ordinances.

D. NUCLEATED

Salient Features

1. Fourteen existing employment and population centers to be designated for the concentration of new urban development.
2. Areas between centers to be kept free from new development, or developed at very low density.
3. Centers to become more independent, more people could both live and work in the same center.
4. Suppliers of public utilities and services, as well as retailers and industries that require large customer and labor markets, to be located in the Regional Center.

Objectives

1. To reduce daily trip length.
2. To reduce required public investment in transportation and community facilities by assembling people into clusters.
3. To preserve investment in existing centers.
4. To provide flexibility for growth beyond 1990.

Strategic Implementation Policies

1. Highways: Expressways that connect developed centers to be built or upgraded. Arterials facilitating circulation within the centers to be built. No major arterial improvements to take place outside the centers.
2. Transit: Required rail extensions from the core to the centers along Route 128 to be built. Remaining centers to be connected to the core by express bus, except for Gloucester. A "jitney" minibus service that connects to a rail rapid transit line to be established in each center.
3. Sewer and Water Facilities. MDC-type sewer and water districts to be established to construct or upgrade and maintain water and sewer service systems. Use of private wells and septic tanks to be prohibited within moderately to intensively developed districts. New development outside centers to rely on wells and septic tanks.
4. Open Space: MDC-type agencies to acquire green belts to limit the growth of the nucleated centers. In addition, each district authority to establish and maintain a system of parks and parkways within each center when more than one city or town is included in the center.
5. Renewal: Selected renewal and rehabilitation to be carried out in older noncore cities that serve as nuclei for new growth.
6. Zoning: Restrictive large-lot zoning to be used in selected municipalities adjacent to centers to encourage and contain development in the centers.

Table 1 DESCRIPTION OF ALTERNATIVE DEVELOPMENT PLANS

Table 2

EVALUATION OF FOUR ALTERNATIVE 1990 PLANS

Plan A: Composite
Plan B: Radial Corridor
Plan C: Controlled Dispersal
Plan D: Nucleated

Objectives	Evaluation Measures	Scores	Ranks
1. Provide Increased Job Opportunities	a. Number of subareas in which the ratio $\frac{\text{1990 Emp./1990 Pop.}}{\text{1963 Emp./1963 Pop.}}$ exceeds 1.25	No. of Subareas A: 35 C: 46 B: 45 D: 43	A: 4 C: 1 B: 2 D: 3
	b. Sum of all subarea highway and transit accessibilities to total employment	Relative Accessibility A: 7,698 C: 8,049 B: 8,155 D: 8,503	A: 4 C: 3 B: 2 D: 1
2. Provide Increased Recreational Opportunities	Sum of highway and transit accessibilities of subareas with major recreational areas to population	Relative Accessibility A: C: B: D:	A: 2 C: 1 B: 4 D: 3
3. Provide Increased Shopping Opportunities	Sum of all subarea transit accessibilities to non-manufacturing employment	Relative Accessibility A: C: B: D:	A: 1 C: 2 B: D:
4. Provide Increased Personal Mobility	Sum of all subarea highway and transit accessibilities to total population	Relative Accessibility A: C: B: D:	A: 1 C: 2 B: D:
5. Provide Personal and Family Privacy	$\frac{\text{Total Population}}{\text{Total Net Residential Acres}}$	Persons/Net Acre A: 14.3 C: 13.4 B: 13.1 D: 13.5	A: 4 C: 2 B: 1 D: 3

Table 2 (Cont.)

Objectives	Evaluation Measures	Scores	Ranks
6. Retain Flexibility for Long-Term Growth	a. Total forecast acres of vacant land available for development in 1990	Acres A: 649,000 C: 623,000 B: 620,000 D: 630,000	A: 1 C: 3 B: 4 D: 2
	b. Forecast number of subareas with remaining vacant land for development in 1990	No. of Subareas A: 2 C: 5 B: 8 D: 2	A: 3 C: 2 B: 1 D: 3
7. Reduce Physical Blight	Total acres released from existing use owing to loss of population or employment	Acres A: 2,618 C: 1,980 B: 2,182 D: 2,354	A: 1 C: 4 B: 3 D: 2
8. Retain the Regional Core Activities	a. $\frac{\text{EMPIRIC 1990 Core Pop.}}{\text{Planned 1990 Core Pop.}}$	Ratios A: 0.82 C: 0.95 B: 0.79 D: 0.89	A: 3 C: 1 B: 4 D: 2
	b. $\frac{\text{EMPIRIC 1990 Core Emp.}}{\text{Planned 1990 Core Emp.}}$	Ratios A: 0.76 C: 0.98 B: 0.70 D: 0.89	A: 3 C: 1 B: 4 D: 2
	c. Change from 1963 to 1990 in the sum of highway and transit accessibilities of the core to population	Relative Accessibility A: -1,158 C: -1,930 B: -1,643 D: -1,856	A: 4 C: 1 B: 3 D: 2
	d. Forecast change in core employment from 1963 to 1990	No. of Employees A: -52,000 C: -18,000 B: -20,000 D: -23,000	A: 4 C: 1 B: 2 D: 3
9. Provide for Orderly Growth	Population served by a municipal piped sewage system	Pop. (Thousands) A: 3,381 C: 3,659 B: 3,358 D: 3,298	A: 2 C: 1 B: 3 D: 4

Table 2 (Cont.)

Objectives	Evaluation Measures	Scores	Ranks
10. Provide for Maximum Recognition of Existing Development Policies and Measures	a. $\frac{\text{EMPIRIC Pop./Net. Res. Acre}}{\text{Planned Pop./Net. Res. Acre}}$	Ratios A: 0.89 C: 0.84 B: 0.82 D: 0.84	A: 1 C: 2 B: 3 D: 2
	b. No. of subareas where residential densities are forecast to exceed existing zoned densities	No. of Subareas A: 18 C: 17 B: 17 D: 17	A: 2 C: 1 B: 1 D: 1
	c. $\frac{\text{EMPIRIC Pop. in Developed Districts}}{\text{Planned Pop. in Developed Districts}}$	Ratios A: 0.81 C: 1.0 B: 0.78 D: 0.57	A: 2 C: 1 B: 3 D: 4
	d. No. of subareas in which the ratio $\frac{\text{EMPIRIC 1990 Pop.}}{\text{Planned 1990 Pop.}}$ exceeds 1.95	No. of Subareas A: 20 C: 21 B: 18 D: 21	A: 2 C: 3 B: 1 D: 3
	e. No. of subareas in which the ratio EMPIRIC 1990 Employment Planned 1990 Employment exceeds 2.05	No. of Subareas A: 27 C: 22 B: 25 D: 23	A: 4 C: 1 B: 3 D: 2
11. Develop Non-Regional Core Activity Centers	Number of subareas containing non-regional core activity centers in which the ratio $\frac{\text{1990 Total Access. to Pop.}}{\text{1963 Total Access. to Pop.}}$ exceeds 1.25	No. of Subareas A: 23 C: 18 B: 13 D: 21	A: 1 C: 3 B: 4 D: 2
12. Minimize Costs of Additional Required Facilities	a. Mileage of major highway and arterial routes	Miles A: 1,776 C: 2,012 B: 1,728 D: 1,866	A: 2 C: 4 B: 1 D: 3
	b. Mileage of rapid transit exclusive of bus and commuter rail	Miles A: 149 C: 70 B: 181 D: 137	A: 3 C: 1 B: 4 D: 2

Table 3

PLAN EVALUATION SUMMARY

	Plan Objective																							
																							SUMMARY	
Plan	1. Provide Increased Job Opportunities		2. Provide Increased Recreational Opportunities	3. Provide Increased Shopping Opportunities	4. Provide Increased Personal Mobility	5. Provide Personal and Family Privacy	6. Retain Flexibility for Long-Term Growth		7. Reduce Physical Blight	8. Retain the Regional Core Activities				9. Provide for Orderly Growth	10. Provide for Maximum Recognition of Existing Development Policies and Measures					11. Develop Non-Regional Core Activity Centers	12. Minimize Costs of Additional Required Facilities		Total	No. of Top Rankings
	a	b					a	b		a	b	c	d		a	b	c	d	e		a	b		
A	4	4	2	1	1	4	1	3	1	3	3	4	4	2	1	2	2	2	4	1	2	3	54	6
B	2	2	4	2	2	1	4	1	3	4	4	3	2	3	4	1	3	1	3	4	1	4	58	5
C	1	3	1	2	2	2	3	2	4	1	1	1	1	1	2	1	1	3	1	3	4	1	41	11
D	3	1	3	2	2	3	2	3	2	2	2	2	3	4	3	1	4	3	2	2	3	2	54	2

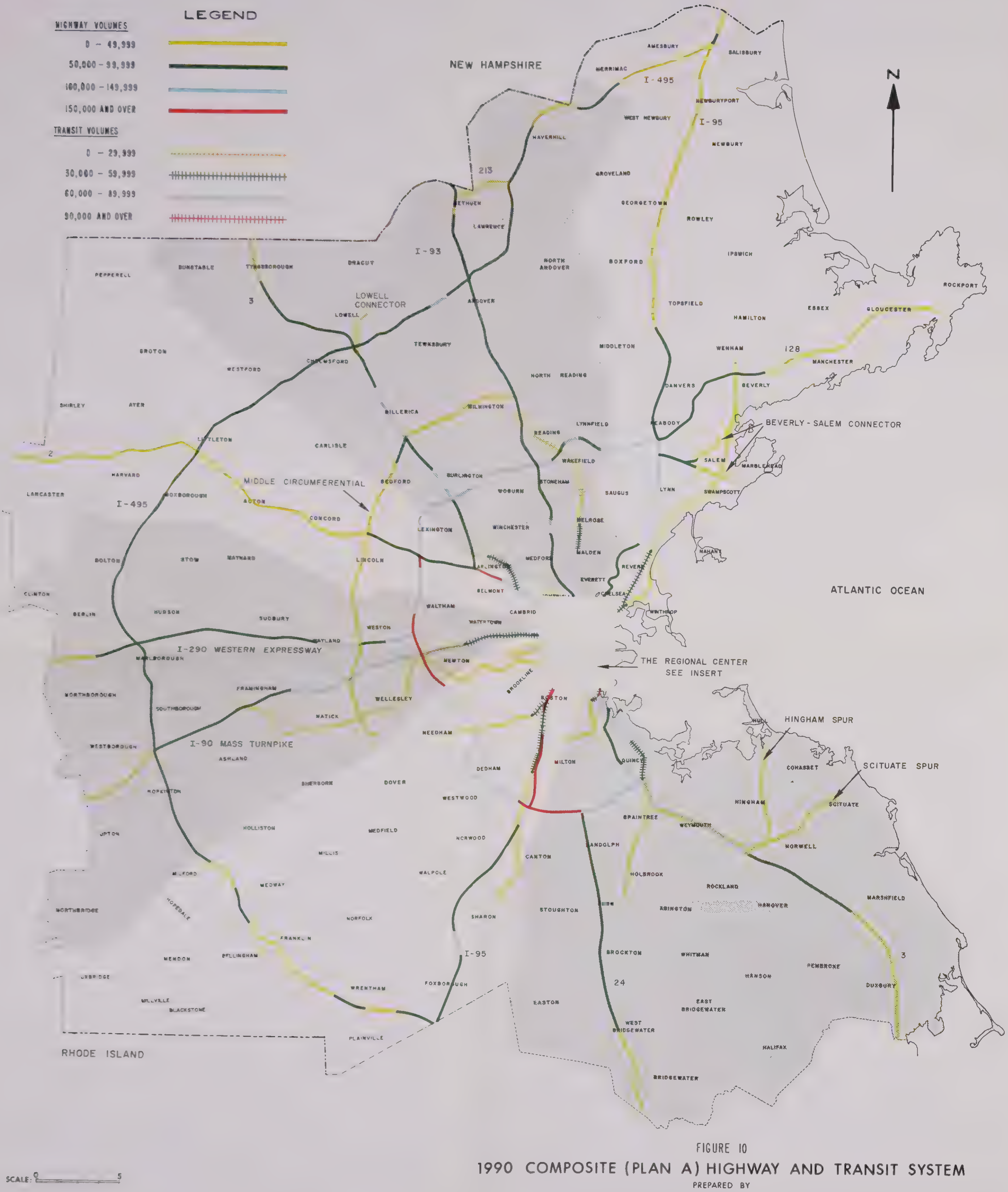
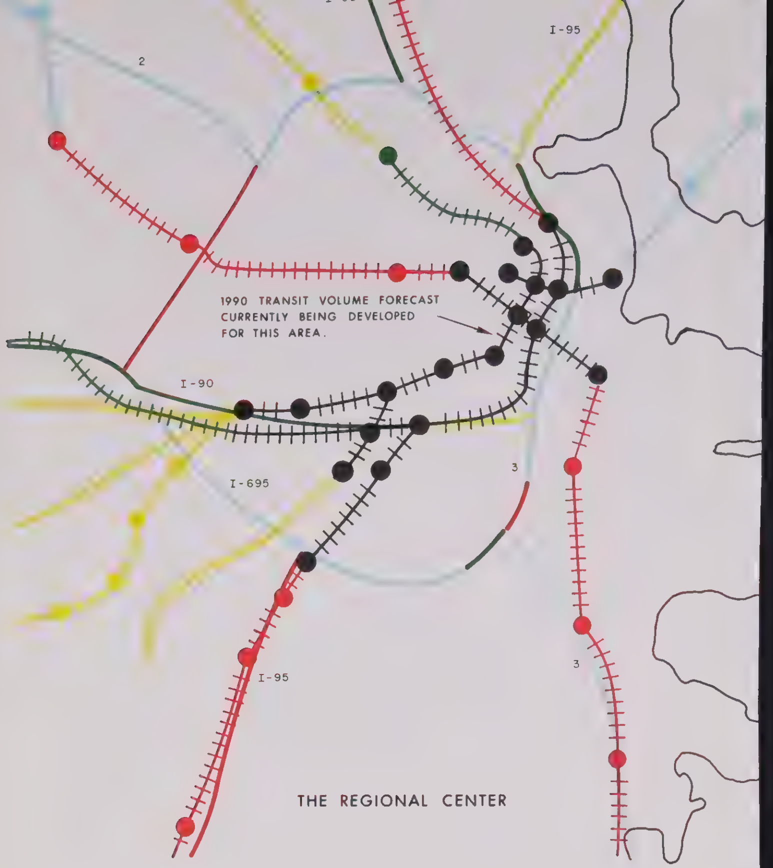


FIGURE 10

1990 COMPOSITE (PLAN A) HIGHWAY AND TRANSIT SYSTEM

PREPARED BY
MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
BUREAU OF TRANSPORTATION PLANNING AND DEVELOPMENT
THROUGH
EASTERN MASSACHUSETTS REGIONAL PLANNING PROJECT
IN COOPERATION WITH THE
UNITED STATES DEPARTMENT OF TRANSPORTATION - BUREAU OF PUBLIC ROADS
OCTOBER 1968


I-95
I-90
I-695
2
3
1990 TRANSIT VOLUME FORECAST CURRENTLY BEING DEVELOPED FOR THIS AREA.

THE REGIONAL CENTER

PLAN A
RADIAL CORRIDOR HIGHLIGHTS

1963	1990		1963	1990
NORTHEAST CORRIDOR			WESTERN CORRIDOR	
590,680	756,316	POPULATION	549,141	763,617
173,714	248,351	EMPLOYMENT	199,281	288,404
178,152	342,192	AUTOMOBILE OWNERSHIP	189,692	403,344
1,169,108	1,610,641	TOTAL PERSON TRIPS	1,123,183	1,767,982
52,338	68,050	PERSON TRIPS TO BOSTON CORE	79,274	111,818
91,679	125,553	TRANSIT PERSON TRIPS	83,968	152,236
25,589	27,705	TRANSIT PERSON TRIPS TO BOSTON CORE	31,774	43,299
862,872	1,236,042	HIGHWAY VEHICLE TRIPS	883,525	1,389,601
22,896	36,760	HIGHWAY VEHICLE TRIPS TO BOSTON CORE	37,470	53,907
NORTHERN CORRIDOR			SOUTHWEST CORRIDOR	
810,615	970,405	POPULATION	454,343	688,043
241,793	323,674	EMPLOYMENT	107,476	215,682
236,944	430,914	AUTOMOBILE OWNERSHIP	131,841	324,674
1,406,216	2,043,833	TOTAL PERSON TRIPS	786,975	1,440,841
65,291	83,502	PERSON TRIPS TO BOSTON CORE	63,485	88,365
109,523	144,984	TRANSIT PERSON TRIPS	93,273	137,713
29,345	34,924	TRANSIT PERSON TRIPS TO BOSTON CORE	32,927	35,663
1,104,993	1,634,985	HIGHWAY VEHICLE TRIPS	588,378	1,156,790
28,274	37,447	HIGHWAY VEHICLE TRIPS TO BOSTON CORE	25,618	42,480
NORTHWEST CORRIDOR			SOUTHEAST CORRIDOR	
292,794	413,470	POPULATION	724,839	1,035,773
90,892	138,292	EMPLOYMENT	182,576	302,693
97,949	211,248	AUTOMOBILE OWNERSHIP	211,261	476,112
519,595	916,450	TOTAL PERSON TRIPS	1,250,684	2,183,698
51,779	63,248	PERSON TRIPS TO BOSTON CORE	97,357	114,635
59,935	86,148	TRANSIT PERSON TRIPS	139,179	189,359
21,588	24,988	TRANSIT PERSON TRIPS TO BOSTON CORE	43,798	50,300
397,774	729,795	HIGHWAY VEHICLE TRIPS	982,355	1,718,538
25,403	31,455	HIGHWAY VEHICLE TRIPS TO BOSTON CORE	46,918	55,919

V. ANALYSIS OF THE ALTERNATIVE TRANSPORTATION PLANS

Two of the four alternative regional plans prepared by the Eastern Massachusetts Regional Planning Project were selected for detailed testing. The two alternative development plans assume the same 1975 highway and transit network, but for 1990 there are two different highway and transit networks. Plan A (the Composite Plan) relies more heavily on transit to accomplish its higher density development objective (see Figure 10). Plan C (the Controlled Dispersal Plan) relies strongly on highways to accomplish its more dispersed land development objective (see Figure 11 on page 113).

This chapter evaluates and compares the two plans. Many factors are covered, including the interrelationships of the highway and transit networks, together with mileage, congestion, and continuity. Factors such as parking locations and access to principal areas, as they appear to meet the people's desires, are also considered in judging the service to the region. How well each plan solves existing problems and provides for the expected increase in travel are additional considerations in the evaluation of the systems. A condensed listing of the advantages and disadvantages of the systems tested is included in Table 4.

Table 4

ALTERNATIVE TRANSPORTATION SYSTEMS

Plan A	Plan C
ADVANTAGES	
• Increases travel capacity in corridors where rapid transit extensions are located.	• Satisfies strong tendency to automobile travel.
• Provides good access and a choice of travel mode for trips destined to the central business area.	• Provides opportunity for dispersed industrial and economic activity.
• Allows provision of parking in low-density areas at transit stations rather than in the high-density central business area.	• Provides greatest access to the region's principal airport.
• Is less disruptive of communities; fewer families dislocated.	• Provides a solution to the existing harbor crossing problems and Central Artery congestion.
	• Is less costly.
DISADVANTAGES	
• Does not keep pace with the growing trend in automobile usage.	• Does not provide sufficiently for travel to the central business area.
• Provides fewer travel facilities outside Route 128.	• Does not provide sufficient transit to relieve the congestion of the highway system.
• Gives no improved access to region's principal airport.	• Includes many "T" intersections of expressways.
• Does not provide a solution to existing harbor crossing problems or to Central Artery congestion.	• Is more disruptive of communities and families.
• Has a greater capital cost.	

The alternative expressway and rapid transit systems are backed by complete networks of arterial and collector streets and bus and railroad lines. However, since the express highway and transit facilities are more important in influencing development than arterial streets or buses, and since the arterials and bus systems are quite similar for both alternatives, this chapter discusses the analysis, need, and adequacy of the express facilities.

SUPPORTING ARTERIAL STREET SYSTEM STUDIES

The arterial street system is treated extensively in the DPW's Bureau of Transportation Planning and Development Statewide Highway Transportation Study. This study encompasses three major objectives, which are described below: functional classification, appraisal of needs and establishment of a long-range construction program of highway improvements, and development of a fiscal plan to finance the program. The study pays careful attention to arterial roads.

The first objective of the Statewide Study is to classify the road system to develop a basis for assigning responsibility for operation, improvement, and maintenance of various roads and streets among the several levels of government in an orderly, rational manner.

The second objective of the Statewide Study is an appraisal of the amount of immediate and future work required to bring the functionally classified system up to appropriate design standards to handle the traffic safely and economically. The determination of existing and future needs provides the basis for the establishment of annual highway program costs, including allowances for replacements, maintenance, and administrative and other costs.

The third objective of the Statewide Study, a fair fiscal policy, was attacked in the fiscal phase, which consists of four steps:

- collection, tabulation, and analysis of historic financial data and statutory background concerning highway revenues and expenditures;
- forecasting of future revenues based on population, vehicle registration, and travel forecasts;
- analysis of the division of tax responsibility between highway users (subdivided among classes of motor vehicles) and nonusers; and
- evaluation of fiscal alternatives based on the relationship of annual program costs to projected revenues from present sources.

This work will be described in subsequent reports of the Bureau of Transportation Planning and Development.

The federal TOPICS Program (Traffic Operations Program for Increasing Capacity and Safety) also deals with arterial streets. The TOPICS Program stresses upgrading urban arterial roads and streets with spot improvements and the application of sound traffic engineering technology. This federal aid highway program is expected to have a major impact on the future operation of the arterial system.

Also concerned with improved arterial operation is the *Guide for Improvements in Traffic Performance,* completed by the DPW through the EMRPP. This report outlines ways that communities can use traffic engineering measures to improve the performance of existing roads and streets.

RELATIVE MERITS OF THE TWO TRANSPORTATION PLANS

After selecting two plans for testing, it is most important to judge their relative merits. This evaluation helps to determine which system would best fit the region's needs, or whether a compromise that incorporates the best features of each system might be necessary.

When the capability of the alternative plan networks to carry the forecast highway travel was assessed, it became apparent that Plan C is generally more successful than Plan A. This is evident at several points, including:

- the Central Artery and the other harbor crossing facilities;
- Route 2 inside Route 128;
- Route 3 between Route 128 in Burlington and I-495 in Chelmsford;
- Route 3 between Route 18 in Weymouth and Pond Street in Rockland; and
- I-95 south of Route 128 in Canton and Norwood.

The Composite Plan is not without its advantages, however, and does ease the strain on:

- the Southeast Expressway;
- I-95 from Route 128 in Canton to the Inner Belt; and
- Route 128 from Lexington to Weston.

Even though Plan A accommodates the forecast travel better on the South Shore and on I-95 near the Inner Belt in Roxbury, neither plan does so adequately. Both plans also indicate potential trouble at the junctions of I-95 with the Beverly-Salem Connector and with Route 128 in Peabody because of the high numbers of vehicles turning. Based on volume forecasts, the only expressways that seem to be unnecessary, at least in their tested form, are the Salisbury Beach Connector and the extension of the present Route 213 through Methuen and Dracut to connect with Route 3 in Chelmsford.

The transit system of Plan C includes implementation of the MBTA's Immediate Action Program, with some minor adjustments and additions. A first glance at the transit loadings seems to indicate that the Plan C transit system would be adequate and that the Plan A transit system is overdesigned. However, the analysis of Plan C demonstrated a series of deficiencies that would require further transit improvements. Parking limitations at the transit stations and capacity restrictions in the subway tunnels would prevent the system from carrying the forecast traffic; that is, an equilibrium transit assignment has not been achieved. Therefore, Plan C would not provide sufficient transit capacity to relieve some of the critically overloaded highways.

Furthermore, most of the transit network included in Plan C either replaces existing inadequate facilities or provides new facilities in areas where the need has existed for years. In fact, detailed analysis of the networks reveals that considerable upgrading of existing facilities is required by 1990 under either plan. The Plan C network would provide only a series of moderate improvements in transit, and would retain several weak characteristics. Broadly, Plan C relies heavily on continuation of railroad commuter service and the use of long-distance bus routes in certain areas.

The 1990 Plan A system provides for rapid transit extensions in each of the major corridors. In conjunction with these extensions, some major improvements in the downtown routing and distribution of transit lines would be required. However, even Plan A did not provide a total solution to the downtown distribution problem, but it demonstrated that people could be diverted from the highways if transit is extended further into areas of high orientation to downtown jobs.

TRANSPORTATION PLAN ANALYSIS BY CORRIDOR

To evaluate the components of the two plans, the process described in Chapter III was used to project future volumes for the highway and transit systems. For these projections, vehicular or passenger volume forecasts for transportation facilities were not restrained by facility capacity or parking restrictions. Figure 10 on page 42 and Figure 11 on page 113 illustrate the volume forecasts on the alternative expressway and rapid transit networks. For the plans illustrated, each transportation corridor was analyzed to determine whether the proposed expressways and rapid transit lines could be constructed with sufficient capacity to handle the forecast volumes. If practical design conditions preclude the construction of adequate facilities, the analysis determined whether the capacity problem could be eased by some diversion of trips to parallel highway or transit facilities.

Following is a detailed description and analysis of the principal elements of the highway and transit networks contained in Plans A and C. Transportation elements are grouped according to present regional travel corridors, both radial and circumferential, to emphasize the interrelationships of the elements of the transportation networks.

Northeast Corridor

The North Shore area is a mixture of residential suburbs and employment concentrations. Logan International Airport is located in this sector, as are some of the major recreational facilities of the region.

The principal radial expressway serving the corridor is Interstate Route 95. Rapid transit service is provided by the Blue Line to Wonderland in Revere. In addition, the MBTA provides bus service to 14 communities in this sector. The North Shore communities are also served by railroad commuter service under the contract now in force between the MBTA and the Boston and Maine Railroad.

HIGHWAY

Interstate Route 95: The forecast average daily travel on I-95 between Salisbury and Route 128 can be adequately served by the existing and proposed facility in both plans. The I-95 volumes in Plan A reach a maximum of 76,000 vehicles per day just north of Route 128. Plan C volumes reach 64,000 vehicles per day at the same point. There are differences of about 15,000 vehicles per day on some sections of I-95 because the Middle Circumferential does not connect with I-95 in Plan A.

The existing section of I-95 north of Danvers was built before the Interstate Highway Program was begun and does not conform to present Interstate Design Standards for speed, approach ramps, median width, and alignment. During summer weekend peak-travel periods, this portion of I-95 experiences severe congestion over its entire length. For these reasons, I-95 from Danvers to New Hampshire is programmed for widening, which has already begun.

I-95 between Danvers and Revere is presently under construction. Projections of future traffic indicate that as many as 145,000 vehicles per day will be carried on I-95 between Route 128 and the Beverly-Salem Connector. Factors contributing to this sizable traffic volume are the inclusion in the network of a New Harbor Crossing and the Connector to Beverly and Salem. The high volume of traffic turning on and off I-95 at Route 128 and at the Connector will cause critical weaving problems on I-95 in this section unless some relief is provided.

A possible alternative to relieve I-95 is the improvement and possible relocation of Route 114 to meet the Beverly branch of the Beverly-Salem Connector. The travel desire for this movement was not expected to be as sizable as developed; therefore, this improvement was not contemplated in the alternative networks. An upgraded Route 114 from North Andover to Route 1 was included in Plan C, and was extended to Route 128 in Plan A, but indications are that the upgrading should have been continued to the Beverly branch of the Connector. This improvement would alleviate the I-95 weaving problem by furnishing a suitable alternate route to Salem and Swampscott from the north and west.

Also, Route 1, which is forecast to carry only moderate traffic between Route 128 and Cutler Circle in Revere, could serve as an alternative route to Cutler Circle and the Northeast Expressway if peak-period congestion begins to occur on I-95.

I-95 from Cutler Circle to the Chelsea approach to the Tobin Bridge (formerly the Mystic River Bridge) was built before the start of the Interstate Highway Program and is substandard according to Interstate Design Standards. Raising this section of roadway to Interstate Standards, however, would be virtually impossible on the present alignment and would elevate the cost of improvement to an unjustified amount. Less costly improvements, such as the addition of acceleration and deceleration lanes designed to meet higher standards, better gradients on some approach ramps, and partial reconstruction of the I-95/Revere Beach Parkway interchange, would substantially increase the safety of this roadway.

I-95 in Charlestown between the Tobin Bridge and the Storrow Drive exit ramps from the Central Artery is presently a source of frustration to peak-period motorists. Severe congestion also occurs in the Sumner and Callahan Tunnels, as commuters frequently face long lines of stopped traffic stretching the length of the tunnel. It is clear that major harbor crossing improvements are needed to handle today's traffic satisfactorily, let alone the increases projected to occur by 1990.

New Harbor Crossing: Traffic using the Tobin Bridge and the Sumner and Callahan Tunnels currently amounts to approximately 120,000 vehicles per day. Improvement of the approach facilities and elimination of restrictions caused by toll collection would allow a total flow of about 160,000 vehicles per day (100,000 on the Tobin Bridge and 60,000 in the Sumner and Callahan Tunnels) at the lowest acceptable level of service.

The daily crossings of the Boston Harbor and Mystic River in 1990 will amount to approximately 186,000 vehicles without a New Harbor Crossing, according to EMRPP forecasts, and 203,000 vehicles with a New Harbor Crossing, according to forecasts made by a consultant for the Massachusetts Turnpike Authority (36). Based on the overload on present facilities by 1990 of 26,000 to 43,000 daily trips, a New Harbor Crossing would be necessary some time after 1975. Unless another harbor crossing is included in the future expressway system, additional capacity will have to be provided on the bridge or the tunnels and improvements will have to be made to the Central Artery in addition to those already anticipated.

Financial studies by the Massachusetts Turnpike Authority's consultant indicate that anticipated toll revenue from this new crossing, if constructed by the Turnpike Authority, would not be adequate to construct the approaches necessary to ensure efficient operation of the roadway system at both ends of the crossing. Therefore, some additional public funding must be found if the project is to become a reality. The possibility of getting Interstate designation for this New Harbor Crossing should be investigated. If this designation is obtained, the construction of this facility could be advanced to the 1968-1975 program to provide relief to the present harbor crossing facilities and the Central Artery at an earlier date.

Shore Expressway: A New Harbor Crossing is not a complete solution without other improvements. The new crossing would carry 72,000 vehicles per day by 1990 and would provide sufficient capacity for all forecast traffic. On the north side of the water, however, complications arise. Both this new crossing and the Sumner and Callahan Tunnels funnel traffic onto Route C-1, which is projected to carry approximately 100,000 vehicles per day just north of Logan Airport and slightly over 70,000 vehicles per day near Bell Circle in Revere. Between Bell Circle and I-95 in Saugus, the average volume forecast for Routes C-1 and 107 is 58,000 vehicles per day. To accommodate these volumes adequately and provide system continuity, a Shore Expressway should connect the New Harbor Crossing with I-95 in Saugus. The construction of an expressway and New Harbor Crossing between I-95 in Saugus and the Inner Belt near South Station would eliminate the need to increase the capacity of the existing Northeast Expressway, Tobin Bridge, and Sumner and Callahan Tunnels.

Of major importance is the excellent access that the Shore Expressway would provide to the region's principal airport. Logan Airport has been a significant factor in the growth of the region, partly because of its accessibility from the central city and the surrounding area. Airline passenger trips for the eastern Massachusetts region are projected to increase by over 300 percent by 1980 (40), and vehicle trips to Logan Airport will continue to grow, even though a second airport may be in use. For the airport to continue to serve the region adequately, it must be easily accessible. The New Harbor Crossing and Shore Expressway would perform this vital function in addition to accommodating the increased number of harbor crossings for other purposes.

Beverly-Salem Connector: The construction of the Beverly-Salem Connector from I-95 in Peabody will provide expressway service to additional communities on the North Shore. In Salem, the Connector branches northeast to Beverly and southeast to the Salem-Swampscott town line. The location of the Connector is the same in Plans A and C. The existing Beverly Harbor Bridge will be replaced by the new facility, which will carry 25,000 vehicles per day, thus helping to relieve peak-period congestion.

The Beverly branch of the Connector carries a maximum of 40,000 vehicles per day in Plan A and 32,000 vehicles per day in Plan C. Without the Beverly branch, travel from north of the harbor toward Boston would use Route 128 in the Peabody, Danvers, and Beverly sections to reach I-95. The Beverly branch will give residents in this area high-speed access to I-95, thereby preventing an increase in travel east of I-95 on Route 128, which carries a heavy volume even with the Connector in the network.

The Salem-Swampscott branch carries a maximum volume of 61,000 vehicles per day in Plan A and 54,000 vehicles per day in Plan C. The volume on the Connector between the fork and I-95 is 71,000 vehicles per day in Plan A and 76,000 vehicles per day in Plan C.

This area of the North Shore does not have other roadways capable of serving an additional 25,000 to 76,000 daily trips. Routes 1A, 107, and 114 are already congested during peak periods and could not handle the added load. The Connector would provide excellent service to the communities of Salem, Swampscott, Marblehead, and Beverly. It would provide an express routing around the business areas and connect with expressways leading in all directions. The cities of Lynn and Revere will directly benefit from relief of the traffic, which will make Routes 107 and 1A more usable for local requirements.

The volumes assigned to the Connector are sufficiently high to justify an expressway facility, and no other reasonable alternative would provide the needed relief to Route 107, which is badly congested during peak periods at the present time.

Revere Beach Connector: The Department of Public Works is presently designing a roadway from Cutler Circle to Revere Beach to relieve the arterials in the Northeast Corridor. This Connector is a recent proposal of the DPW and was not tested in the alternate networks. It appears that such a facility would not only serve recreational traffic but would relieve certain arterial roadways in the area.

TRANSIT

Blue Line: Under Plan C, North Shore transit service is essentially the same as today, while under Plan A the Blue Line rapid transit service is extended from Wonderland to Route 128 in North Beverly. An express operation would bypass all stations between the existing Airport Station and Revere Marshes. The Suffolk Downs station would become seasonal, operating only during the racing season at the Suffolk Downs racetrack.

Available parking at the existing Wonderland terminal of the Blue Line is now limited to approximately 500 spaces, and it is estimated that by 1990 the demand will increase to approximately 3,000 spaces without an extension of the line. In addition to relieving this potential traffic and parking problem at Wonderland Station, an extension to a point just beyond Route 128 in Beverly would attract an estimated 18,000 riders, increasing the number of daily passengers carried at the peak-load point from 62,000 to 80,000. However, if the rapid transit line is not extended beyond Wonderland, some of the forecast park-ride transit trips would be lost because of insufficient parking and would become highway trips to downtown Boston instead.

At the present time, the MBTA is studying the engineering feasibility of extending the Blue Line from Wonderland to a new terminal in the vicinity of Route 107 and the Pines River; or Vinnin Square, Salem; or Route 128 in Beverly. A short extension to the vicinity of the Pines River appears justified as part of the short-range transit program to provide the necessary additional parking capacity. The terminal must include a large parking lot accessible primarily from I-95 and Route 107 and must allow for the further extension of rapid transit to the north as part of the long-range program.

Essential to the viability of the Blue Line transit extension is better downtown distribution. This can be most effectively accomplished by a subway link in downtown Boston connecting the Blue Line with a rapid transit line in the Western Corridor. The feasibility of this link is being examined in the MBTA's Central Area System Study. A short branch extension into the Logan Airport terminal complex to permit direct rapid transit service from downtown to the terminal building is also being studied in cooperation with the Massachusetts Port Authority.

With the provision of better downtown distribution, a rapid transit extension would divert more people from the highways than either railroad or express bus service. With through service downtown and better airport access, which were not tested in the alternate plans, the number of additional riders carried on the Blue Line should substantially exceed the 18,000 forecast for Plan A.

Beyond 1975, the problems associated with reducing costs, changing union work rules, providing adequate equipment, operating over a right-of-way harmoniously with freight service, and improving downtown distribution are so severe that the alternative of providing transit service to the North Shore by a combination of a rapid transit extension and integrated bus service will be required. The potential increase over the Plan A forecast that results from better downtown distribution and Western Corridor through service, together with the infeasibility of providing the required number of parking spaces without an extension, indicates that a rapid transit line to the vicinity of the Salem Connector would be the most practical solution to the long-range transit requirements for the Northeast Corridor.

Assuming that the recommended plan testing and detailed economic studies substantiate the need for the extension described, the station locations and parking space estimates for the Blue Line would be as follows:

Station	Parking Spaces
Maverick	0
Airport	100
Wood Island	500
Orient Heights	260
Suffolk Downs	120
Beachmont	210
Revere Beach	180
Wonderland	480
Pines River	2,500–3,500
Lynn	0
Swampscott	100
Salem Connector	1,000–2,000
Total	5,450–7,450

In conjunction with the Blue Line extension, Plan A tests an express transit track from Pines River to Airport Station that would bypass the intermediate stations. The additional riding attracted because of the time saved by such a bypass may be sufficient to justify its construction in conjunction with an extension to the Salem Connector. Further testing and design of the Shore Expressway should consider the possibility of including this express transit facility in the right-of-way.

Another option for providing through rail transit service between the North Shore and Western Corridors would be by a new rail transit harbor crossing built in conjunction with the new highway harbor crossing. This crossing would permit the use of wider, longer transit cars than the present limited-diameter transit tunnel under the harbor would allow. It would, however, have the serious disadvantage of bypassing many major transit trip generators in the downtown area, such as the redeveloped waterfront, the financial district, Government Center, and the retail core.

If the increased ridership that would be generated by better downtown distribution is not adequate to justify the cost of the required service and facilities, the Blue Line should not be extended beyond Pines River. In this event, the long-range transit service would probably be greater use of express buses. One alternative would be to have these buses feed the rapid transit terminal at Pines River. Another would be to run the buses directly into downtown Boston via the New Harbor Crossing to a new bus terminal at South Station.

Northern Corridor

With large sources of labor at both its northern and southern limits, this commuter-oriented sector is witnessing industrial growth and development. Interstate Route 93, now being completed, is the primary link between downtown Boston and the urbanized Merrimack Valley. Route 3 is the principal route to the Lowell area from Route 128.

At the present time, the MBTA provides rapid transit service to Charlestown and Everett and bus service to most communities in the sector. The Boston and Maine Railroad provides rail commuter service to Malden, Melrose, Reading, Wakefield, Wilmington, Winchester, and Woburn under a service contract with the MBTA. The transit extension of the Orange Line to the Malden-Melrose town line from Haymarket Square in Boston is under construction.

HIGHWAY

Interstate Route 93: The completion of 2.0 miles of I-93 through Medford and Somerville before 1975 is the highest priority highway project in this corridor. This project is already under construction. When completed, I-93 will be continuous from the New Hampshire line at Methuen to the Inner Belt.

I-93 between the New Hampshire state line and I-495 should be able to carry the forecast average daily travel easily, with one exception. The bridge over the Merrimack River creates an extremely dangerous situation. The number of lanes decreases from six on either side of the bridge to four on the bridge. While signs warn of the impending lane reduction, motorists traveling at speeds up to 65 miles per hour are unprepared for such an occurrence. Although the reduction in lanes is not a critical factor in average daily travel, it is critical for recreational travel. Severe tie-ups occur at this section during summer weekend travel peaks and when Rockingham Park race track in New Hampshire is operating; the situation is compounded when the two occur simultaneously. The bridge-widening project is scheduled for construction bids before the end of 1968.

Forecast volumes on I-93 between I-495 and the location of the Middle Circumferential of Plan C are nearly identical in the two plans. South of the Middle Circumferential, the volumes change significantly between the alternative plans; the Plan C volume is 94,000 vehicles per day, or 28,000 higher than Plan A. The differences in length and location of the Middle Circumferential and the changes in intensity of land use resulting from these factors contribute to the variation in volumes on I-93. The major parallel facilities, Routes 28 and 38, do not receive excessive use except on either side of the interchanges with Route 128 and in town centers. These are local problems for which it is impossible to make recommendations without more detailed study than is contained within the scope of the EMRPP.

The differences between the volumes on I-93 in the alternative plans decrease approaching the core area. Some of the reduction in traffic volume in Plan A can be attributed to the rapid transit extension in the corridor, but the exact amount is impossible to pinpoint because of the interacting factors of land use, trip generation, modal split, and trip distribution. Under either plan, I-93 should be able to carry the maximum forecast volume of 117,000 vehicles per day between Route 128 and the Inner Belt.

Route 3: Route 3 is a 4-lane expressway extending from the New Hampshire state line in Tyngsborough to Route 128 in Burlington. In the section north and west of Lowell, Route 3 carries between 35,000 and 65,000 vehicles per day. The Plan A volumes are slightly higher than those in Plan C because the number of trips in this area is greater in Plan A and because the Plan C network includes proposed Route 213, which diverts some of the traffic to and from the east.

Route 3, including the Lowell Connector south of I-495, carries approximately 90,000 vehicles per day in Plan A and 75,000 in Plan C. Between Route 128 and I-495, the traffic volumes forecast for Route 3 are at least 15,000 vehicles per day higher in Plan A, with some segments 35,000 higher. Under either plan, these volumes are high for a 4-lane expressway, particularly in Plan A. The Middlesex Turnpike is very lightly loaded and could serve as a suitable alternative for some of the Route 3 traffic during peak periods.

North of the Middlesex Turnpike, Routes 3A and 4 carry substantial volumes, and the capacity of the corridor on Route 3 and parallel roadways is closely approached in Plan A. Some improvements to these alternate facilities might be necessary before 1990 under this plan. In Plan C, the volume forecast for Route 3 is diminished but the capacity of Route 3 is still strained. The primary reason for higher volumes in Plan A is the continuity of the route, which extends inside Route 128 to meet with Route 2 in Lexington. If additional corridor capacity is necessary, one option would be the improvement of parallel arterials. Another option would be to widen Route 3.

At Route 128, the corridor volumes are nearly equal in both plans (about 165,000, vehicles per day) but in Plan A, Route 3 carries about 22,000 more vehicles.

In Plan A, which includes the Route 3 extension, the average volume on Route 2 between the junction of Routes 2 and 3 and Alewife Brook Parkway is 148,000 vehicles per day, or 16,000 higher than in Plan C. Traffic concentration would be at the allowable maximum under the level-of-service criteria, and the roadway would operate on the brink of unstable flow conditions. In Plan C, some traffic is diverted to other facilities and the strain on Route 2 is eased. For this reason, it appears inadvisable to join the Route 3 expressway to Route 2. Because "T" intersections of expressways are basically undesirable, another option could be considered at some future date. This option would be to extend Route 3 to connect with I-93, which will have some excess capacity in 1990.

TRANSIT

Orange Line: The Orange Line is currently being relocated and extended from an improved Haymarket Station through a new tunnel under the Charles River and along the Boston and Maine Railroad right-of-way to a terminal at Oak Grove in Malden.

Plan A contains a further extension to I-93 in Wilmington. This plan includes express bus service between Lawrence and the Wilmington terminal via I-93 and between Haverhill and the Wilmington terminal via I-495 and I-93.

In Plan C, the Orange Line rapid transit extension terminates at Oak Grove near the Malden-Melrose town line. Under this plan, express bus service from Lawrence and Haverhill feeds into

Sullivan Square. Plan C also includes express bus service from Reading and Wakefield to Sullivan Square and from Melrose to Oak Grove.

Under Plan A, an estimated 17,300 inbound daily riders would be delivered to the transit line by express and local bus lines. In Plan C, the bus network would deliver an estimated 18,000 riders to the rapid transit line. Both plans assume the termination of railroad commuter service on the Reading Branch of the Boston and Maine Railroad.

In Plan A, with its superior relationship to Route 128 and I-93, the estimated daily transit ridership on the Orange Line is 95,800. In Plan C, 1990 daily ridership is estimated at 83,400. However, the parking demand projected for Wellington and Oak Grove in Plan C is far greater than can be provided. The poor transit-highway relationship and the lack of parking along an Orange Line terminating at Oak Grove would turn away some of the estimated park-ride and kiss-ride patronage, and the estimated ridership on the line would not materialize. The number of riders lost for this reason, added to the 12,000 daily riders attracted by extending the line beyond Oak Grove, might justify the cost of constructing six additional miles of rapid transit to Route 128 after 1975.

Assuming that the recommended plan testing and detailed economic studies substantiate the need for the extension described, the station locations and parking space estimates for the Orange Line would be as follows:

Station	Parking Spaces
Community College	0
Sullivan Square	2,000
Wellington	2,000
Malden	150
Oak Grove	600
Wyoming	50
Melrose	200
Wakefield	200
Route 128	3,000
Total	8,200

Express bus service from Burlington, Woburn, Winchester, Medford, and Somerville to a major bus terminal at North Station should be tested in the recommended plan. If such a terminal proves feasible and Boston is able to handle the additional bus traffic, express bus service from Lowell and Lawrence could also use the terminal. Also, the feeder bus network serving this corridor would be adjusted and expanded as the Orange Line is extended.

While the rapid transit extension is being subjected to further detailed analysis, consideration of a further extension to Wilmington should not be ruled out. However, if the Orange Line terminal remains at Oak Grove, additional riding could be encouraged by an across-the-platform transfer from railroad to rapid transit at Oak Grove, or by a busway on the railroad right-of-way north of the rapid transit terminal. By this means, the communities north of Malden would have substantially better access to the Oak Grove terminal than that provided by the highway network.

Green Line: Neither the extension of the Green Line to Washington Street, Somerville, as contained in the 1966 *Program for Mass Transportation,* nor the conversion of the Green Line to Blue Line rapid transit and its extension to Broadway, as proposed in Plan A, generates a sufficient increase in transit riding to justify construction.

Since daily transit ridership is estimated at only 31,000 if the Boston and Maine Railroad's New Hampshire Division right-of-way were converted to rail rapid transit (as in Plan A), or 25,900 if the Green Line is extended (as in Plan C), bus transit service in this corridor would seem the logical long-range recommendation. The New Hampshire Division right-of-way through Winchester, Medford, and Somerville will still be used for freight service. If rail commuter service is continued, it will probably be on a short-term basis only.

Somerville is heavily transit oriented and service should be improved. Since the rail transit alternative has not yet been justified, the alternative of improved bus service appears to be the most promising solution. Under this alternative, the Green Line streetcar service would become a downtown shuttle terminating at North Station. Somerville would be served by express bus service over the Lechmere viaduct to a terminal at North Station. However, the feasibility of constructing such a busway and a North Station terminal has not been thoroughly studied. Green Line streetcar service to Lechmere would continue under the short-range program. Nevertheless, the possibility of long-term retention of rail commuter service on the New Hampshire Division, Green Line low-platform transit service to Lechmere, or other rail transit improvements through Somerville should be recognized as future options.

Northwest Corridor

At the present time, this corridor is poorly served radially by both transit and highways. However, a portion of Route 2 is currently being rebuilt to expressway standards and the MBTA's *Program for Mass Transportation* contains an extension of the Cambridge subway from Harvard Square to Alewife Brook Parkway.

In addition to the Harvard subway, the MBTA operates bus or trackless trolley lines in 14 of the sector's towns. Present transit service in this corridor also benefits from the Authority's service contracts with the Middlesex and Boston Street Railway and the Boston and Maine Railroad.

The principal radial highways are Routes 2 and 3. Both the Route 128 and I-495 circumferentials have an important impact on the sector's activities.

HIGHWAY

Route 2: The forecast volumes on Route 2 are extremely close in Plans A and C outside Route 128. The only significant difference appears in the Middle Circumferential area, which is located differently in the two plans. Otherwise, the forecast volumes vary less than 5,000 vehicles per day between the plans. The volumes increase from 28,000 vehicles per day at the regional boundary to approximately 70,000 at Route 128.

The substantial volume on Route 2 west of Route 128 in both plans appears to justify the proposed upgrading of this facility to a completely limited-access expressway. Since the volumes assigned can be accommodated adequately by an upgraded Route 2, it does not appear that major improvements to any of the parallel arterials will be necessary, except where required to solve local problems.

The travel projections for Route 2 east of Route 128 are affected by the Route 3 expressway terminal point. In the Composite Plan, the Route 3 expressway is extended from its present terminus at Route 128 in Burlington to Route 2 in Lexington near the Lexington-Arlington town line. In the Controlled Dispersal Plan, Route 3 as an expressway remains in its present configuration and terminates at Route 128. Stopping Route 3 as an expressway at Route 128 disperses some of the corridor travel to Route 128 and to the arterial and local systems. While "T" intersections of expressways are not generally a good policy, in this instance it has the advantage of reducing somewhat the projected volume on Route 2 in a potential problem area. The chief disadvantage is the additional load placed on Route 128 in a section already heavily loaded.

Reconstruction is presently underway on the segment of Route 2 between Alewife Brook Parkway and Route 128. The 1990 projected volume on this portion of Route 2 reaches a maximum of 141,000 vehicles per day in Plan C, which does not include the Route 3 expressway extension. This volume approaches the capacity of the 8-lane expressway being constructed from Alewife Brook Parkway to Routes 4 and 225 in Lexington, where the forecast maximum volume occurs. Six lanes are being constructed with a provision for an increase to eight lanes from Routes 4 and 225 to Route 128, where the maximum volume forecast is 120,000 vehicles per day.

The segment of Route 2 from Alewife Brook Parkway through Cambridge is forecast to carry a maximum volume of 145,000 vehicles per day in Plan C. Volumes of this magnitude cannot be adequately carried by existing Route 2, which has a series of signalized intersections, rotaries, and sections of narrow, winding roadway. The 8-lane design planned for the new Route 2 through this area is badly needed to relieve currently congested Memorial Drive, Alewife Brook Parkway, and Fresh Pond Parkway. Based on forecast traffic volumes, which approach the capacity of an 8-lane facility, some peak-period traffic might divert to parallel arterials. With some improvements, Massachusetts Avenue and Concord Avenue should be able to accommodate diversions from Route 2.

TRANSIT

Red Line: By 1975, Route 2 will extend inward only to Alewife Brook Parkway. Relief must be provided for this Alewife Brook focal point, which will experience intolerable congestion without further expressway and transit improvements. The Red Line, therefore, should be extended to Alewife Brook Parkway by 1975.

As proposed in Plan C, the extension of the Cambridge subway from Harvard Square to Alewife Brook Parkway at the Cambridge-Arlington-Belmont town lines would take the form of a subway under Massachusetts Avenue to Porter Square and a surface line along the Fitchburg Division of the Boston and Maine Railroad in conjunction with the extension of Route 2. A terminal would be built in the vicinity of the intersection of Route 2 and Alewife Brook Parkway. This facility would be a major park-ride as well as feeder bus terminal.

Plan C provides continued railroad service to Lowell, using the Fitchburg division of the Boston and Maine Railroad. In Plan A, the Red Line extension beyond Alewife continues along the Boston and Maine Railroad right-of-way through Arlington Center and Lexington Center to the Route 3 expressway extension in East Lexington. The East Lexington terminal is fed by express buses from the Concord and Lowell areas via Routes 2 and 3.

If unlimited parking is assumed, the extension to Alewife Brook Parkway will add an estimated 52,800 riders to the present 80,000 riders on the Red Line. This additional riding would not fully materialize without an extension of the line to reach parking facilities adequate to satisfy the estimated demand for 6,700 spaces at Alewife or beyond. Past experience with construction of rapid transit extensions, however, has demonstrated the difficulty of providing an adequate number of spaces.

An extension to Lexington rather than Alewife Brook Parkway would add 11,600 more daily riders for a total line ridership of 144,400. The Plan A parking demand is estimated at 4,600 at Alewife and 9,400 at East Lexington.

Development plans for the Alewife site, combined with limited land area available for parking, preclude the provision of more than 3,000 transit parking spaces; 2,000 is a more likely figure. It is anticipated that future development of the Alewife Brook site will include a concentration of residential, recreational, employment, and shopping activities. Thus, this station would also attract outbound work trip riding from the urban area, which was not considered in the forecast. A rapid transit extension beyond Alewife would be useful for trips originating in the suburbs with destinations at Alewife, Harvard Square, and downtown Boston, and would ease the excessive parking demand at Alewife by substituting parking at the stations farther out.

The need for an efficient relationship between the transit stations and the highway system is obvious. Even though Lexington would not generate sufficient local traffic to justify rail rapid transit, further analysis may prove that construction of the Red Line through Lexington may be justified to intercept major highways where large parking lots can be provided. In the Plan A network, the extension of Route 3 through East Lexington enables the transit line to terminate at that point. Without an extension of Route 3, the next major highway is Route 128.

Assuming that the recommended plan testing and detailed economic studies substantiate the need for the extension described, the station locations and parking space estimates for the Red Line would be as follows:

Station	Parking Spaces
Harvard Square	0
Porter Square	0
Alewife Brook Parkway	2,000
Arlington Center	100
Arlington Heights	500
East Lexington	1,000
Lexington Center	100
Route 128	2,500
Total	6,200

Since the Route 128 terminal would be in an area of high traffic volume and potential congestion, it might prove feasible to extend the line beyond Route 128, perhaps to the Middle Circumferential in Bedford, to intercept radial traffic. However, this extension appears to be extremely difficult to justify economically.

If a detailed study proves that construction beyond Route 128 is economically unjustified, a reorientation of bus operations will be necessary to serve the rest of this corridor's transit demand. In any event, a major revision in bus service in the entire Northwest Corridor will be necessary to support the rapid transit extension. Feeder bus service plays a significant role in this sector. In Plan C, an estimated 31,100 of the 66,400 daily inbound riders are delivered to the rail transit line by feeder bus. In Plan A, buses would deliver an estimated 26,900 of the 72,200 daily inbound riders. Many of the new primary feeder bus routes will serve Porter Square and Alewife Brook Stations. Local service will continue to serve the entire area. In addition, the bus service now provided by the Middlesex and Boston Street Railway Company should be integrated into the MBTA system.

Bus service from the rapid transit line should be provided to employment concentrations along Route 128, the Middle Circumferential, and I-495, as well as to the Lowell metropolitan area, since commuter railroad service will probably be discontinued prior to 1990.

Western Corridor

The Western Corridor, like the Southwest, is a link between the Boston area and the other urban centers of the northeastern megalopolis. The rapid growth now occurring in this corridor can be expected to continue, compounding the need for improved transportation.

The major radial arterials in the Western Corridor are Routes 9, 16, 20, and 30. Circumferential expressways include Route 128 and I-495.

The Western Corridor is the only one in which a toll road, the Massachusetts Turnpike (Interstate Route 90) serves as the principal expressway. A toll road gives good long-distance travel service but does not provide the surrounding communities with the same accessibility levels or development opportunities as a toll-free road, because of the restraints imposed by tolls and greater spacing between interchanges. Therefore, the communities west of Boston are somewhat handicapped by the lack of expressway service.

Present transit service to the Western Corridor is unique. Riverside Line streetcars operate within an exclusive right-of-way, express bus service from suburban communities operates directly into the

Boston central business district, and bus service operates from the inner city to some Route 128 industries, offering inner city residents increased accessibility to employment.

The Boston and Albany line of the New York Central Railroad, a major east-west through railroad link, passes through this sector, and the continued use of this line for freight and possible long-haul passenger service should be anticipated.

HIGHWAY

Massachusetts Turnpike: From the region boundary to Route 128, the Massachusetts Turnpike appears able to carry the projected 1990 traffic without an increase in capacity. The forecast traffic on the Turnpike outside Route 128 is lower in Plan C, primarily because Plan C includes Route 209, which offers a limited-access high-speed alternative. Route 209 also draws traffic from Route 9.

The Massachusetts Turnpike between Route 128 and the Beacon Park Yards carries up to 119,700 vehicles per day with an average of 114,000 vehicles in both plans. This forecast volume taxes the capacity of the Turnpike severely. However, some of this overload can be diverted to Routes 9, 16, 20, and 30. These four routes between Route 128 and the Inner Belt have a capacity well above the projections in both plans.

In the testing process, the time restraint used to simulate the effect of the toll was less than it should have been. In the recommended network testing, a more appropriate constraint will be imposed which will result in a more reasonable distribution of corridor traffic. With Routes 9, 16, 20, 30, and the Turnpike, the corridor will have adequate capacity, but travel speeds will be reduced because of the heavy use of these roadways.

From Beacon Park to the Southeast Expressway, the Turnpike should easily carry the 1990 forecast trips.

Western Expressway: The proposed Western Expressway, a continuation from I-290 at I-495 in Marlborough to Route 128 in Weston, would provide a second continuous routing from Route 128 to the west. Primarily intended to relieve the heavily traveled part of Route 20, the Western Expressway would serve the expanding suburban communities west of Waltham.

In Plan A, the forecast volume on the Western Expressway ranges from a low of 33,000 vehicles per day in Northborough to a high of 111,000 at the Middle Circumferential. The forecast volume in Plan C ranges from 31,000 in Northborough to 111,000 at Route 128. The combined forecast volume on Route 20 and the Western Expressway ranges from 60,000 to 116,000 vehicles per day in the alternate networks. Route 20 alone is not capable of carrying this amount of traffic.

The Western Expressway would provide good access to the fastest growing part of the corridor and to the residential and industrial complexes that are expected to develop around I-495 in the Hudson-Marlborough area. This accessibility would allow workers to live some distance from these new plants and still commute in a reasonable time. Even though the Western Expressway and the Massachusetts Turnpike are closer together than freeway spacing criteria normally recommend, the fact that one is a toll road makes the spacing acceptable.

The termination of the Western Expressway at Route 128 puts an additional strain on Route 128, which will be operating at or above capacity. To counteract the disadvantage of a "T" intersection of expressways, it is desirable to have arterial routes continuing from the intersection. In this instance, Route 20 and the Western Expressway join just west of Route 128, and there will be an opportunity to continue on Route 20 east of Route 128. Route 20 passes through the heart of Waltham, however, and its capacity to handle large volumes of traffic is limited by traffic signals and parked vehicles. Nevertheless, the radial travel demand inside Route 128 is not of sufficient magnitude, when balanced against community disruption, to require the continuation of this expressway east of Route 128. Substantial traffic engineering improvements to Route 20 would be required to handle any additional traffic the Western Expressway would generate. An option of terminating some of the through lanes at the Middle Circumferential has been considered to help alleviate the strain on Route 128. This does not seem to be desirable, however, as it would be contrary to the forecast travel desires on the Western Expressway, which in Plan C reach a maximum in the section adjacent to Route 128.

TRANSIT

Riverside Line: The Plan C network contains an upgrading of the existing Riverside Line, including roadbed improvements and new rolling stock, while in Plan A, the Riverside Line is complemented by rapid transit service from downtown Boston to Framingham on the Penn Central Railroad right-of-way.

In Plan C, daily ridership on the Riverside Line between Riverside and Fenway Park is 45,000 passengers. However, without an extension beyond Riverside, this number of passengers would not be attained because the stations lack sufficient parking spaces.

The Framingham rapid transit line of Plan A accommodates an estimated 35,000 daily riders between Framingham and Newtonville, while the Riverside line retains 27,200 for a corridor total of 62,200. This figure is substantially below the comparable ridership in other corridors. The dispersed employment pattern and the sizable amount of other transit service provided in the corridor account for these relatively low passenger estimates. Plan C, for example, contains express bus service to downtown Boston via the Turnpike from Waltham, in addition to the present service from Watertown Square. This express service would accommodate an estimated 8,600 daily riders.

Plan C also preserves the railroad commuter service from the western suburbs, carrying an estimated 4,600 daily riders.

Both plans continue streetcar service using reserved medians in Beacon Street and Commonwealth Avenue. In Plan A, 39,400 daily riders would be carried on these lines and in Plan C, the daily forecast is 40,400.

Even though substantial transit service is available, it does not serve the corridor's growing areas adequately. Unless major improvements or extensions are provided, the growth of transit ridership in this sector will be stifled. Immediate improvements should include a replacement of the present Riverside cars by new low-platform vehicles. If the Riverside Line is later transformed into a high-platform line, the new cars would be placed in service on the Beacon Street and Commonwealth Avenue Lines, replacing the equipment now operating on those lines.

For the longer term, the best means of serving this corridor appears to be the extension of the Blue Line to the vicinity of the Natick-Wellesley line via a new downtown tunnel and Riverside Line high-platform transit service. The alternative of rapid transit service to Framingham via the Penn Central Railroad right-of-way produced only 35,000 daily riders. A through routing to Logan Airport and the North Shore might produce sufficient additional riders to justify this alternative, but its construction would reduce the riding on the Riverside Line to the point where any improvement of that line or even its continuation might be difficult to justify.

Under either alternative, the existing 1,600-car parking lot at Riverside would become inadequate. It is anticipated that approximately 5,000 parking spaces would be needed by 1990 if this station were to remain the terminal, and 3,000 spaces would be required if the line were extended beyond Route 128. To reduce the traffic on Route 128 by intercepting radial traffic destined for transit stations and to furnish the parking spaces required, an extension beyond Route 128 is necessary. Approximately 40 percent of the present Riverside Line riders originate in towns not served directly by the line. This considerable proportion of the total would be better served by the further extension.

Assuming that the recommended plan testing and detailed economic studies substantiate the need for the extension described, the station locations and parking space estimates for the Riverside Line would be as follows:

Station	Parking Spaces
Brookline Village	200
Brookline Hills	50
Reservoir	200
Chestnut Hill	100
Newton Center	0
Newton Highlands	100
Waban	40
Riverside	3,000
Wellesley Hills	150
Wellesley	500
Wellesley-Natick	3,000
Total	7,340

The strength and nature of the orientation of Western Corridor towns to downtown Boston and the demand for high-platform rapid transit service need further analysis to insure that the routing, length of extension, and characteristics of the transit line are optimum to serve the market.

From the success of the Watertown Square-Newton Corner to downtown Boston express bus route, it seems reasonable to expect an expansion of this type of service along the Turnpike as the private carriers serving the corridor go out of business and their routes are integrated into the MBTA system. This service would operate to terminals in the Back Bay and South Station areas. An option that should also be considered is the use of the Penn Central Railroad right-of-way for exclusive bus lanes.

The streetcar service to Watertown Square and commuter railroad service do not appear to warrant continuation, but the low-platform transit vehicles operating out of the Central Subway serving the Fenway, Brookline, and Brighton perform a very useful function and should be continued.

Southwest Corridor

The Southwest Corridor is expected to be one of the major growth sectors of the region, and is the link between the Boston and Providence-Pawtucket metropolitan areas. The principal radial highways are I-95 and Routes 1 and 109. The only circumferential today is Route 128. This corridor has no high-standard highways inside Route 128 at present.

Existing transit serving this corridor includes Orange Line rapid transit, MBTA bus service in six communities, four commuter lines of the New Haven Railroad, and private carrier bus lines.

Transportation proposals for this sector are highlighted by the joint construction of Interstate Route 95 and the MBTA Orange Line rapid transit extension, with a common right-of-way extending from Roxbury to Readville. This section of I-95 will be known as the Southwest Expressway.

Any transportation improvements that are developed in the current Northeast Corridor studies of the U.S. Department of Transportation will be provided within this corridor.

HIGHWAY

Interstate Route 95: The corridor volumes paralleling I-95 between I-495 and Route 128 range from 116,000 to 172,000 vehicles per day in Plan A. Corridor volumes in Plan C range from 111,000 to 133,000 vehicles per day. I-95, which is six lanes wide through this area, is forecast to carry between 70 and 90 percent of this corridor volume. The inclusion of the Middle Circumferential in Plan C affects the volumes of adjacent segments of I-95, which are about 24,000 vehicles per day higher south of the Middle Circumferential interchange and about 18,000 lower north of the interchange than the corresponding links in Plan A. The Middle Circumferential acts both as a diversionary influence and as a contributor toward the difference in trip distribution between the two plans.

In Plan A, the corridor volume of 172,000 vehicles per day near Route 128 would tax the capacity of the three major parallel facilities (I-95, Route 1, and Route 1A) despite a sizable expansion of rapid transit in the corridor. The reduction of these volumes to the more manageable level of 157,000 adds to the justification for a Middle Circumferential through this corridor.

The forecast volume on I-95 in Plan A between Route 128 in Canton and the Inner Belt in Roxbury ranges from 148,000 vehicles per day at Cummins Highway in Roslindale to 190,000 vehicles per day at Jackson Square in Jamaica Plain. In Plan C, the volume ranges from 164,000 at Cummins Highway to 204,000 at Jackson Square. The corridor volume exceeds the I-95 volume by approximately 35,000 to 40,000 vehicles per day in both plans.

Major arterials within the Southwest Expressway corridor carry nearly equal volumes in both plans. Because of local traffic conditions, parking problems, and restricted capacity, both Washington Street and Hyde Park Avenue are near the congestion stage at the present time, especially during peak periods. However, the assignment process allocated much less travel to these facilities than their traffic-handling capability would allow. The same is true of other arterials in the corridor. Both plans show a total of 39,000 vehicles per day on the Jamaicaway, Washington Street, and Blue Hill Avenue (north of the American Legion Highway) while 1963 traffic counts indicated 85,000. Therefore, even though the assigned volumes on I-95 are quite high, there appears to be enough capacity in the corridor to handle the major portion of the future demand if improvements are made to the arterial system. On Route 1, for example, the rotary at the intersection of Centre Street and the Arborway would need to be eliminated, and the proposal to make the Jamaicaway a one-way pair on opposite sides of Jamaica Pond and Muddy River would need to be implemented. Some means of bypassing or improving traffic flow through Mattapan Square would be necessary to allow Route 138 to serve as an effective alternate route to the core area. Washington Street and Hyde Park Avenue could handle a substantial portion of the corridor traffic if they are improved in the Forest Hills area. These improvements include the removal of the elevated transit system on Washington Street and relocation of the Forest Hills Station.

Inside Route 128, this corridor is clearly the most heavily traveled in both networks. Even though the improvement of the arterials will provide reasonable alternate routings for I-95 traffic, the corridor volume of 240,000 vehicles in the inner section is dangerously close to the corridor capacity. Peak-period congestion will probably continue to occur on some of these routes. It may be necessary to consider providing more expressway lanes sometime in the late 1980's. Increased use of transit, especially during peak periods, will be the controlling factor. To provide any significant relief to the highway system, the Orange Line must be extended at least to Route 128.

Route 209: The Plan C network tests a proposed expressway, Route 209, extending from the town of Uxbridge in the southwest corner of the region to Route 128 near the Westwood-Dedham town line. This proposed route is forecast to carry from 45,000 to 51,700 vehicles per day between I-495 and the Middle Circumferential. In the sector between the Middle Circumferential and Route 128, the volume ranges between 65,400 and 76,000 vehicles per day.

An effect of Route 209 can be shown in the differing volumes on adjacent sections of I-495. In Plan A, the volumes on I-495 in this area are about 13,400 vehicles per day higher than in Plan C.

The volumes projected for existing Route 109 between I-495 and Route 128 range from 10,900 to 59,000 vehicles per day in Plan A and from 6,900 to 46,800 vehicles per day in Plan C.

The closest parallel arterial to Route 209 is Route 16, which carries approximately 7,000 fewer vehicles per day in Plan C from I-495 to Route 27, where it diverges from its parallel course with Route 209. The effect on Route 16 is most marked outside I-495. Without Route 209, Route 16 would carry from 20,000 to 37,800 more vehicles per day from Mendon to Route 109 in Milford.

Route 135, the northern arterial of the corridor, shows a slight decrease of approximately 4,800 vehicles per day with the inclusion of Route 209.

Both development plans indicate substantial growth in the Route 109 corridor, even if no new facilities or improvements to existing facilities are constructed. Therefore, major improvements appear to be required. An expressway facility can be justified to a point west of the center of Mendon, where the forecast volume dwindles from 30,000 to less than 15,000 vehicles per day. System continuity dictates that Route 209 be terminated at another roadway of similar standards, rather than at a lower class facility. Therefore, Route 209 should either stop at I-495 or continue to Route 146 in Uxbridge. Since the forecast corridor travel through Mendon is over 30,000 vehicles per day, it appears that the full extension to Route 146 would be necessary to furnish relief to Route 16.

Whether extended to Uxbridge or stopped at I-495, Route 209 would be in the center of the largest remaining expanse of territory not presently served by a high-standard radial facility. It will open up the southwestern portion of the region for development, and provide relief to the existing radial arterials.

One disadvantage of Route 209 is that it creates another "T" intersection of expressways at Route 128, forcing additional traffic onto that overcrowded roadway. The addition of Route 209 in Plan C diverts some traffic from Route 9 and the Massachusetts Turnpike corridor to Route 209, Route 128, and I-95, placing more pressure on the latter two facilities. This diversion could amount to 15,000 vehicles per day. Route 109, which continues from the junction of Route 128 and proposed Route 209, is the best alternative for handling any significant amount of radially oriented traffic that would otherwise traverse Route 128 until reaching an acceptable radial route. However, this section of Route 109 would need to be improved from Route 128 to the Veterans of Foreign Wars Parkway. When combined with the improvement of Centre Street and the Jamaicaway, good alternate routes toward downtown Boston and excellent access to the VFW Parkway rapid transit station on the Orange Line would be provided.

TRANSIT

Transit improvements for the Southwest Corridor will be coordinated with the construction of the Southwest Expressway and will assist in the renewal of the City of Boston by permitting the demolition of the elevated tracks through the South End, Roxbury, and Jamaica Plain.

The 1966 MBTA *Program for Mass Transportation* includes the relocation of the Orange Line to the present main line of the New Haven Railroad, where it will be incorporated into the median strip of the proposed Southwest Expressway between Roxbury Crossing and Readville. A branch of the Orange Line from Forest Hills through West Roxbury is also included in the MBTA Program.

In Plan C, the Southwest Corridor system contains rapid transit extensions both to the VFW Parkway via the Needham branch of the New Haven Railroad and to Readville via the main line. The Orange Line of Plan C is forecast to carry 134,300 daily passengers between Forest Hills and Northeastern Station. This total includes 30,000 passengers from the West Roxbury Branch and 37,800 from the Readville Branch.

Shorter rapid transit lines must depend more heavily on feeder bus routes. The extensions contained in Plan C pick up 30,600 of a total of 67,200 inbound daily riders from feeder bus lines.

Railroads will continue to run in this corridor. The intercity service of the New Haven Railroad is expected to continue along the main line of the New Haven after absorption into the Penn Central. In Plan C, some rail commuter service was continued along both the New Haven main line and the Blackstone Branch, with an estimated 1990 daily ridership of 14,800 passengers.

Plan A includes a much more extensive rapid transit network, extending to Needham Junction to the west and to the Sharon-Walpole town line in the vicinity of I-95 to the south, but discontinues Blackstone Branch railroad service.

The branch of the Orange Line to Needham will attract substantial walk-in patronage from Needham, West Roxbury, and Roslindale, as well as park-riders from the corridor served by Route 209. This extension would serve the regional recreational complex proposed for the VFW Parkway-Charles River area. Forecast ridership on this branch is 32,000 daily passengers.

The extension from Forest Hills to the Canton-Norwood-Sharon area is estimated to carry 50,600 passengers per day without a station at Route 128. If a Route 128 station were added, the total should increase.

It is estimated that the Orange Line in the Southwest Corridor, including both branches, will carry 153,200 passengers per day, compared to the present ridership of 94,000 passengers per day. Only 26,900 of the 76,600 inbound daily riders are transfers from feeder buses, a much smaller percentage than in Plan C. Extension of rapid transit to Route 128 and beyond increases the rapid transit riding in the Southwest Corridor by 19,000 trips.

The relocated line to Forest Hills and the two branch extensions will be essential in attracting commuters away from their automobiles for at least part, if not all, of the trip. Otherwise, highway capacity in this corridor would be severely overtaxed by 1990 during peak periods. The Southwest Expressway and the relocation of the railroad are scheduled for completion prior to 1975. It is important that transit service to Route 128 be in operation by that time. It does not seem reasonable to expect that rapid transit extensions beyond Route 128 could be economically justified in this corridor.

If the recommended plan testing and detailed economic studies substantiate the need for the extensions to Route 128, the station locations and parking space estimates for the Orange Line would be as follows:

Station	Parking Spaces
Medical Center	0
Back Bay	0
Massachusetts Avenue	0
Northeastern	0
Roxbury Crossing	0
Jackson Square	0
Forest Hills	100
Roslindale Center	150
West Roxbury	300
Temple Street	500
VFW Parkway	1,500
Route 128, Needham	2,000
	4,550
Forest Hills	100
Cummins Highway	0
Cleary Square	0
Readville	1,000
Route 128, Canton	2,000-3,000
	3,000-4,000

This system would continue interurban railroad passenger service into South Station via the Midland Branch of the New Haven Railroad, but Blackstone Branch service would be discontinued and replaced by buses.

Longer range options include continuing the Readville Branch to the Sharon-Norwood-Canton area and extending the Needham Branch to a terminal at Needham Junction. Rapid transit extensions beyond Route 128 permit the interception of park-ride and kiss-ride trips and help ease the traffic burden on this expressway but appear to be difficult to justify economically.

Plans for this corridor must recognize the high-speed interurban transportation improvements that are expected to emerge from the Northeast Corridor studies of the U.S. Department of Transportation. For example, a high-speed train will soon be running between New York and Boston, with intermediate stops at Providence and Route 128. Intercity railroad passengers may be attracted to switch to rapid transit at a Route 128 transfer station, since transit would offer direct access to the Back Bay and better downtown Boston distribution. If this transfer occurs, it would raise the transit ridership forecast for this corridor.

A second major airport may be located southwest of Boston, since studies to date indicate that this sector contains the most suitable location for it. It may be feasible and necessary to extend Orange Line rapid transit to this airport, depending on its location.

Southeast Corridor

This corridor has been the fastest growing corridor in recent years and is expected to continue to grow at a rapid rate in the future.

The South Shore has been without rail passenger service since 1959 and is served only by Red Line rapid transit and bus lines at the present time. The seriously congested Southeast Expressway testifies to the lack of adequate transportation in this sector.

The principal radial expressways serving this sector are the Southeast Expressway, Route 3, and Route 24. The principal circumferential is Route 128. Rapid transit service is provided from downtown Boston to Ashmont.

The South Shore is a residential sector with a strong orientation toward downtown Boston as a center of employment. It offers a good market for improved transit service. The South Shore rapid transit line to South Braintree is currently under construction.

HIGHWAY

Southeast Expressway: The Southeast Expressway is an existing 6-lane facility extending from Route 128 in Braintree to the Central Artery. In Plan C, the Expressway carries from 100,000 to 142,000 vehicles per day between Neponset Circle and Route 128. A 6-lane roadway cannot carry 142,000 vehicles per day with a tolerable level of service, and there is no suitable alternative route that could offer relief. The Plan A volumes range from 84,000 to 125,000 vehicles per day, which are slightly more manageable. Nevertheless, considerable peak-period congestion would occur.

Corridor volumes between Neponset Circle and the Inner Belt are nearly identical in both plans, ranging from 125,000 to 140,000 vehicles per day. This traffic can be accommodated by Morrissey Boulevard and the Expressway, but probably not without some peak-period slowdowns.

Several alternate schemes to improve the highway system in this corridor are possible. For example, metering ramps, closing ramps, or relocating ramp connections could improve the flow of traffic on the Expressway. Another option is to make a continuous, high-standard arterial comprised of Route 3A, the Southern Artery, Sea Street, and Morrissey Boulevard. Greater dependence upon transit to carry peak-period commuters is a third alternative.

None of these alternatives, however, is both feasible and sufficient to produce the desired results. Traffic engineering improvements would probably not produce the substantial capacity increase necessary to handle the corridor volume. The difficulties of reconstructing Route 3A, the Southern Artery, Sea Street, and Morrissey Boulevard or Hancock Street through the central business district of Quincy or along Wollaston Beach appear to be insurmountable. The expanded transit system in Plan A did not reduce the highway volumes significantly. It does not seem reasonable to assume that a large number of motorists could be attracted to transit in addition to those already forecast. Transit improvements are necessary, but transit alone will not provide the solution. Therefore, some form of highway improvement in this corridor is required. Since major arterial improvements seem impractical, a more realistic solution is to increase the capacity of the Southeast Expressway by adding lanes.

Shawmut Trail: The proposed Shawmut Trail or a modified arterial version is contained in both Plans A and C. In Plan C, the Shawmut Trail is an expressway extending from Routes 128 and 3 in Braintree to Route 3A at Fore River, where it turns eastward paralleling Route 3A to Hingham. In Plan A, the proposed arterial route extends from Routes 128 and 3 in Braintree and joins Route 3A in Quincy, just before the Fore River Bridge.

With the Shawmut Trail expressway, there is an average decrease of 12,500 vehicles per day on Morrissey Boulevard and Route 3A in Quincy and an increase of about 17,000 vehicles per day on the Southeast Expressway between Neponset Circle and Route 128. Only minor differences occur on the Southeast Expressway and Route 3 north and west of Neponset Circle. A new bridge over the Fore River, replacing the old structure, carries 63,500 vehicles per day in Plan C. The existing structure, which is retained in Plan A, carries 47,000 vehicles per day. This increase of approximately 16,000 continues in this corridor through Weymouth and into Hingham, indicating the attractiveness of the Trail. About 30,000 vehicles per day are carried on the segment that bypasses Hingham Center.

Forecast traffic on the Shawmut Trail expressway between the Fore River Bridge and Routes 3 and 128 is from 20,000 to 80,000 vehicles per day greater than traffic on the proposed arterial of Plan A. The Shawmut Trail attracts the majority of trips from the area destined to and from the north and west on the Southeast Expressway and Route 128 and to and from the south on Route 3. The arterial scheme does not provide the same level of service and therefore is not as heavily utilized.

The Shawmut Trail, while relieving Route 3A, Morissey Boulevard, and the local street system, is not without its disadvantages. The additional load placed on the Southeast Expressway can only cause added congestion on the already heavily loaded facility. The discharge of 100,000 vehicles per day onto Routes 3 and 128 would necessitate special, costly ramp connections to avoid severe weaving problems.

By 1990, some form of relief will have to be provided to this area. In addition to the previously discussed traffic engineering improvements, arterial improvements paralleling the Southeast Expressway, and reliance on transit, another alternative considered was the construction of arterials or the improvement of existing arterials to provide access from Weymouth and Hingham to Route 3 in a generally north-south direction. However, arterials probably would not be sufficiently attractive to draw substantial amounts of traffic from other arterials. For example, the Shawmut Trail is forecast to carry 100,000 vehicles per day at Route 3, while the proposed arterial in virtually the same location is forecast to carry only 30,000. Even in a favorable location, this proposed arterial did not draw sufficient traffic from other Quincy arterials to relieve the present traffic congestion problem; arterials in less favorable locations, oriented basically in a north-south direction, counter to the primary travel desires, would be even less likely to furnish needed relief to the Quincy arterial street system.

The Shawmut Trail expressway therefore appears to be the most practical solution for facilitating vehicular movement along the South Shore. A connection with the Hingham Spur would also be desirable to preserve system continuity and offer partial relief to Route 3. The Shawmut Trail proposal is currently encountering opposition from communities in the area. These objections should diminish, however, as traffic congestion continues to increase.

Expanding the capacity of the Southeast Expressway and constructing the Shawmut Trail with direct connections to the Southeast Expressway and Route 128 west, together with the rapid transit extension to Braintree and beyond, should contribute substantially toward solving one of the region's major transportation problems.

Route 3: Route 3 is a 6-lane expressway from the Southeast Expressway to Route 18 and a 4-lane expressway from that point to the region boundary. The forecast traffic volumes on Route 3 are similar in the two plans from the region boundary to the Pond Street interchange in Rockland. The existing 4-lane facility would adequately serve the forecast demand to this point. North of Pond Street, the divergence between the volumes carried under the two plans is between 5,000 and 15,000 vehicles per day. The forecast volumes in both plans between Route 18 and Pond Street, which range from a low of 90,000 vehicles per day in Plan C to a high of 106,000 vehicles per day in Plan A, are above the capacity of a 4-lane expressway. Route 53, a parallel facility, is lightly loaded but is not well suited to serve through trips, which are the chief concern.

Route 3 is an extremely heavily used recreational route during the summer because it is the most direct route to the South Shore beaches, Cape Cod, and Martha's Vineyard and Nantucket Islands. The Southeastern Massachusetts Area Transportation Study has made a summer weekend travel forecast for 1990, and has recommended widening Route 3 from four to six lanes south of the EMRPP boundary to accommodate summer weekend recreational travel. Widening Route 3 in the EMRPP area would also appear justified, since it must carry the South Shore beach traffic as well as Cape Cod traffic.

The forecast volume between the Route 3/Shawmut Trail interchange and the Southeast Expressway jumps to 177,000 vehicles per day in Plan C and 147,000 in Plan A. An elaborate ramp and direct connector system would be required to allow adequate operation of this section of roadway. Otherwise, serious weaving problems would result.

Route 24: The Route 24 forecast traffic volumes are extremely close in both alternative plans, differing by no more than 5,000 vehicles at any point. Route 24 carries 33,000 to 90,000 vehicles per day in Plan A and 33,000 to 87,000 vehicles per day in Plan C. The existing route, which is four lanes wide from the region boundary to the Pond Street interchange in Avon and six lanes wide from that point to Route 128, should be able to carry the 1990 forecast travel without difficulty. The termination of Route 24 at Route 128 is a contributing factor to the overloaded condition of Route 128 in this area. At the present time, it does not appear feasible to continue Route 24 north from this point with an arterial roadway or to connect with either Route 28 or Route 138, because either alternative would require taking land in the Blue Hills Reservation. However, because the distance between Route 24 and Route 28 is short, possible approval might be granted at some future date.

The difference in forecast volumes on parallel arterial Routes 138 and 28 are very slight, except where the effect of the Middle Circumferential is felt in Plan C. The only apparent problem occurs on the two routes just south of Route 128. Route 138 is forecast to carry 40,000 vehicles per day and Route 28 from 45,000 to 50,000 vehicles per day by 1990. These are local problems, however, and improvements should be made when the situation demands.

Hingham-Scituate Spur: The Hingham Spur generally follows old Route 128 from Route 3 at the Norwell-Rockland line to Washington Park Boulevard in Hingham. The Scituate Spur terminates at Route 3A.

The forecast volume on the spur before the split to Hingham and Scituate is about 50,000 vehicles per day in both plans; the Plan C volume is slightly higher because of the continuity provided by the Middle Circumferential. Each branch is assigned at least 15,000 vehicles per day, with the Scituate branch forecast to carry 25,000. These volumes indicate that improvements are warranted in this area, and an expressway facility appears justified. However, there is presently a controversy concerning this Spur, and the communities of Norwell and Hingham may not wish this type of improvement.

The Spur would be an excellent connector for two other expressways, the Middle Circumferential and the Shawmut Trail. If the Hingham Branch were not included in the recommended network, the Shawmut Trail would be terminated at Route 3A, just east of the Weymouth Back River.

TRANSIT

Red Line: The South Shore has been without rail service for several years; however, a rapid transit extension is now under construction. This extension is a branch of the Red Line in a southerly direction from the subway portal between Andrew and Columbia Stations along the right-of-way of the former Old Colony Line of the New Haven Railroad to South Braintree at the intersection of Union Street and Route 3. This remains the terminal in Plan C. Plan A tests extensions in two directions beyond that point: to a location near the Rockland-Norwell border on one branch, and to the Montello section of Brockton on the other.

Ridership on the South Shore extension of the Red Line is forecast at 54,800 passengers in Plan C. In Plan A, the total daily ridership on the line is 70,400 passengers. Of this total, the Brockton and Norwell branches each carry 15,400 riders.

An extension beyond South Braintree is needed as part of the long-range program, primarily to relieve the extreme demand for parking at the Braintree stations. Without such an extension, the parking demand by 1990 at the North and South Braintree stations would exceed the off-street supply by more than 2,500 spaces. In addition to meeting the parking demand, the extension along Route 3 would relieve street traffic congestion in Braintree by diverting kiss-ride and park-ride traffic to the new stations. A location in the vicinity of Route 18 in South Weymouth appears to be the most suitable terminal point for this branch line. Because of the anticipated volumes, a further extension along Route 3 to the Middle Circumferential in Norwell may be justified at a later date.

Because of its length, the Brockton extension does not appear to be economically feasible at this time. It should be considered a long-range possibility, at least until the plans currently being prepared by the Old Colony Planning Council are further developed. Until such a rapid transit facility can be justified, bus service from Holbrook, Randolph, and other communities would be provided to the Braintree stations.

Assuming that the recommended plan testing and detailed economic studies substantiate the need for the extension described, the station locations and parking space estimates for the Red Line would be as follows:

Station		Parking Spaces
North Quincy		900
Wollaston		500
Quincy Center		750
North Braintree		900
South Braintree		1,400
South Weymouth		3,000
	Total	7,450

Mattapan Project: The 1966 MBTA *Program for Mass Transportation* was revised in 1968 to include a 2½-mile upgrading of the Ashmont-Mattapan high-speed streetcar line to high-platform rapid transit, consistent with the remainder of the Red Line. Storage and shop facilities for rolling stock are to be provided at Mattapan to free the Eliot Street Yards in Cambridge for the construction of the John F. Kennedy Memorial Library.

The Mattapan project is a rapid transit extension project authorized in 1923 but left incomplete in 1928 because of a shortage of funds. Because of this previous work, the Mattapan upgrading can be accomplished at the lowest cost per rider of any of the proposed rapid transit extensions. Further, it is the sole remaining streetcar line in the area and incurs high labor and maintenance costs, which will be eliminated by standardization of Red Line equipment.

At the present time, approximately 108,000 daily riders use the Dorchester section of the Red Line, with 17,000 transferring between lines at Ashmont. By 1990, this volume is estimated to drop to 89,000, including 10,000 Mattapan trolley transferees at Ashmont in Plan C, and to 86,000 passengers, including 8,600 transferees, in Plan A. Both plans continue the existing high-speed trolley line; the network analyses do not reflect the rapid transit extension. The decline in patronage results from other extensions tapping the existing Red Line market areas south of the Neponset River and development in the area served by the Dorchester line north of the Neponset River not keeping pace with development elsewhere. This decline might be partially checked by improving the attractiveness of this line and by encouraging development along it.

The City of Boston Master Plan recommends that Mattapan Square be developed as a District Center. Direct rapid transit access would enhance the Center's effectiveness; conversely, a District Center at a rapid transit terminal would contribute to transit riding.

As a means of helping to reverse the predictions of decreased use of this line, it would be advisable to increase the number of parking spaces between Ashmont and Mattapan from the 760 now available to the following minimum number:

Station		Parking Spaces
Ashmont		150
Butler		500
Milton		100
Mattapan		800
	Total	1,550

Highway volumes from the south will increase so severely by 1990 that traffic improvements will be required at Mattapan Square. It is anticipated that the parking increases could be instituted at the same time as the arterial street improvements to assure effective coordination between street and parking improvements.

The Regional Center

The Regional Center consists primarily of commercial and industrial areas with residential concentrations in some sections of Boston and Cambridge. The principal expressways serving this sector today are the Central Artery and Storrow Drive. Feeding into the Central Artery are the Northeast Expressway, Sumner and Callahan Tunnels, and the Southeast Expressway.

All the rapid transit lines of the MBTA pass through or terminate in downtown Boston. Three railroads also serve this area. The commuter trains from the southwest and west terminate at South Station, while trains from the north terminate at North Station.

This sector is a most critical area. To preserve this central area as a vital force in the economic scheme of the region, transportation improvements both within the central area and linking it with the suburbs are badly needed.

HIGHWAY

Inner Belt: If one of the region's expressways were to be selected as the most important, it would be the Inner Belt. This loop serves the most highly developed area of the region and is the connecting link between seven of the region's most important expressways. The Inner Belt (I-695) extends westward from I-95 in Charlestown to I-95 in Roxbury. The alignment of I-695 between I-93 and I-95 in Charlestown is fixed. The portion between I-93 and the Boston-Brookline town line is opposed by some groups in Cambridge. A portion of I-95 is the connecting link between the Inner Belt and the Central Artery.

The forecast volumes on the Roxbury and Brookline sections of I-695 reach a high of 150,000 vehicles per day in Plan C and a low of 124,000 under Plan A. The Cambridge section has a forecast volume of 160,000 vehicles per day under Plan A, approximately 10,000 higher than in Plan C.

The EMRPP has recently completed a crude forecast of 1990 travel that points out the consequences of not building the Inner Belt through Cambridge. For the forecast, the remaining portion of the Inner Belt was connected with Route 2 to the north and Memorial and Storrow Drives to the south. With the Cambridge section of the Belt removed, the predicted volume of 160,000 vehicles per day disperses over a number of lower standard roadways, causing points of congestion which would lead to critical design problems. The redistribution of Cambridge Inner Belt traffic results in the following major problem areas:

- Alewife Brook and Fresh Pond Parkways;
- Boylston Street and Anderson Bridge;
- Storrow Drive and Memorial Drive; and
- the Central Artery.

The extra traffic burden on these facilities is forecast even with a complete circumferential arterial roadway between the Inner Belt and Route 128, generally following the alignment of Routes 60, 16, 20A, and 3. The route formed by these arterials is forecast to carry between 30,000 and 60,000 vehicles per day in both alternative networks and is the major reason that the forecast traffic on the Inner Belt did not exceed 160,000 vehicles per day.

Not only does the Inner Belt provide access to downtown Boston and a bypass route for traffic wishing to avoid the core area, but it also connects the corridors that comprise the study area. Without the Inner Belt, the rest of the system is severely impaired.

The need for an Inner Belt has been substantiated by every metropolitan Boston highway study made in the last 30 years. The Federal Highway Administrator, Department of Transportation, has now directed that a final study be made concerning the implications of eliminating the Cambridge section of the Belt. On the assumption that the Inner Belt proves justified, a study of design alternatives for the proposed Brookline-Elm alignment is being made concurrently. This study takes into account social and economic factors and the inclusion of the Belt in urban renewal and model cities programs. The results of these studies, called Task A and Task B of the Inner Belt Re-Study, will finally resolve the question.

New Harbor Crossing: The main difference between Plans A and C in the Regional Center is a New Harbor Crossing included in Plan C. The projected volume on this New Harbor Crossing is 72,000 vehicles per day. The addition of this facility reduces the volume in the Sumner and Callahan Tunnels by 48,000 vehicles per day, on the Tobin Bridge by 26,000 vehicles per day, and on the Central Artery by approximately 28,000 vehicles per day.

This crossing has been fully discussed under the Northeast Corridor, as it is intimately related to the highways in that corridor.

Central Artery: The Central Artery, which will become a segment of I-95, is below Interstate Design Standards. Upgrading this facility to Interstate Standards is a minimum requirement; a study currently under way indicates that widening may also be necessary.

There is a potential congestion point on the Central Artery just south of the Turnpike Extension/New Harbor Crossing interchange. Carefully planned connections between the new crossing and the Southeast Expressway/Inner Belt junction area must be built so that the system can function efficiently and smoothly.

The proposed Leverett Circle-Charlestown Bridge in the Charles River Dam area will have a beneficial effect on the Central Artery. This bridge and its connections will permit direct movement from Storrow Drive to Charlestown and the Tobin Bridge. This direct connection would allow the elimination of the northbound entrance and southbound exit ramps between Leverett Circle and the Central Artery, thereby alleviating congestion on the Artery and at Leverett Circle. Leverett Circle badly needs relief from present congestion, and this proposed project would accomplish the desired results.

Other highway improvements contemplated for the Regional Center were developed mainly by the Boston Redevelopment Authority. The most significant of these is the South End Bypass, which penetrates the South End from the junction of the Southeast Expressway and the Inner Belt to the frontage road along the Massachusetts Turnpike. This high-standard arterial is a factor in reducing travel on the Inner Belt and the Central Artery, as it furnishes an alternate route for travel to downtown.

PARKING

An investigation of parking needs for the region reveals that for downtown Boston, the provision of adequate parking spaces will be one of the factors that determines a properly functioning regional transportation network. In this core area, the 1963 estimated parking space demand was 44,800 (16). The actual inventory of 47,920 spaces in 1967 indicates that demand and supply were nearly equal. However, Plan A projects a demand of over 113,000 spaces in 1990, while Plan C indicates a demand of over 102,000 spaces.

The comparison of these figures to the 1967 inventory demonstrates the importance of parking and the restriction that will be placed on future automobile travel to the downtown core if parking needs are not met by providing sufficient parking at transit stations as well as downtown. The 1990 demand for some 55,000 to 65,000 new parking spaces in the downtown Boston area far exceeds the number to be provided according to present policies of the City of Boston. Therefore, more extensive testing of the modal split (the division of total person travel between highway and transit modes) with the inclusion of higher parking fees is needed. The new garages and lots that will be built should be situated at the edge of the downtown core, and good distribution facilities into the core should be provided.

TRANSIT

Mass transportation primarily accommodates peak-period work trips to concentrated employment centers. Historically, major employment concentrations have been located principally in the center of the urban region and, according to present trends, will remain there. To be effective, a public transportation system must offer both convenient access to the core from the suburbs and excellent distribution and collection within and among the many activities in the center.

Distribution deficiencies exist in the present transit lines downtown. In the elongated downtown area, only the overloaded Green Line subway system serves the Back Bay. Additional direct access to the Back Bay will be provided when the Orange Line is relocated to the New Haven Railroad's main line tracks.

The New Haven Railroad's interurban passenger service to South Station via the Midland Branch is expected to be the only railroad passenger service running in 1990.

New Downtown Tunnel: A major downtown distribution improvement will occur if the proposed new downtown subway connecting the East Boston Blue Line with a line serving the Western Corridor proves feasible. Several alignments for the downtown subway are being examined in the MBTA's current central area system study. In one of the most attractive alternatives, the existing Riverside Line would be converted to high-platform service, becoming part of the through Blue Line via a new downtown tunnel. For the recommended plan testing, the new tunnel connects Bowdoin Station with Park Street Station.

Diversion of Western Corridor transit service from the Boylston Street Green Line subway will relieve the current overloaded condition during peak periods. In addition, a through Blue Line would provide a direct interconnection of all rapid transit lines within the Central Area. This improved rider distribution and increased capacity will be necessary to accommodate the new passengers generated by the suburban rapid transit extensions.

Green Line: The Green Line, or Central Subway, remains a low-platform downtown shuttle service between North Station and Kenmore Square with surface extensions along Huntington Avenue, Beacon Street, and Commonwealth Avenue.

Other Improvements: Other necessary improvements to the subway distribution system within the downtown area include lengthened platforms on the Red and Orange Lines, station modernization, and new stations at the Tufts-New England Medical Center, in the Back Bay, and at North Station.

If the express bus service described in the Northern and Western Corridors proves desirable, new bus terminal facilities will be required downtown in the North Station, South Station, and Back Bay areas. The precise locations of these possible terminals have not been determined.

As a supplement to the subway system, bus and railroad terminals, and parking garages, the downtown area should be served by some other means of distribution. The City of Boston is proposing to undertake feasibility studies of a distribution system in cooperation with the MBTA and the DPW. This system might take the form of a minibus network, moving sidewalks at selected locations, or the like.

Circumferential Transit: A circumferential transit line tying together many activity centers near downtown Boston is under study and may be proposed at a later date. These activity centers include Harvard Square, Kendall Square-MIT, Boston University, and the Fenway educational-medical complex.

Middle Circumferential Corridor

This portion of the region has experienced dynamic growth because of the development that occurred along Route 128, which is the only expressway serving this area. No circumferential rapid transit service exists or is proposed for this area and nothing in the analysis reveals an obvious need for such service. Both plans assume that circumferential transit routes would be limited to bus routes connecting employment concentrations with rapid transit or commuter railroad stations.

HIGHWAY

Route 128: Route 128 is a circumferential expressway around Boston, approximately 10 miles from the core city. It extends from Gloucester on the North Shore to Route 3 in Braintree on the South Shore. In the years since this road has been open for travel, housing and industry have grown tremendously in the area that the expressway serves.

Route 128 east of I-95 is a low-standard expressway without complete control of access or grade separation of all intersections. The section from Route 127 in Gloucester to Route 1A in Beverly is a 4-lane expressway. Forecast 1990 volumes for this section range from 12,000 to 50,000 vehicles per day. At these volumes, the highway is operating within its capacity except during summer weekend recreational periods. Forecast volumes range from 70,000 to 100,000 vehicles per day in both plans between Route 1A and I-95. These volumes exceed the capacity of the existing 4-lane expressway. Upgrading this section of Route 128 should be given high priority because of the high traffic volume forecast and because of the safety hazard caused by interruptions in the traffic flow.

Improvement of Route 128 to the level necessary to meet the future travel demand is possible in this section on the present right-of-way. The combination of daily and recreational traffic is sufficient to justify upgrading low-standard sections between I-95 and Route 127 to full expressway standards. Additional capacity will also be required from I-95 to Route 1A or at least to Route 62, with access fully controlled.

The section from I-95 in Peabody to I-93 in Reading is either six lanes wide or is planned for six lanes. The forecast volumes range from a low of 80,000 to a high of 124,000 vehicles per day. Plan A has a uniformly higher volume of traffic than Plan C. This volume differential may be partly attributed to the extension of the Middle Circumferential between I-93 and I-95 in the Plan C network. The volumes on Route 128 in this section indicate that a 6-lane expressway would be adequate except from I-93 to Route 28, where a volume of 120,000 vehicles per day is forecast in both plans.

Route 128 is presently six lanes wide between I-93 and Route 3A and eight lanes wide between Route 3A and Route 3 in Burlington. The forecast volumes reach a high of about 140,000 vehicles per day on this section. The difference in volume between the plans is slight. The capacity of the 6-lane section is exceeded by these high volumes, and severe congestion will occur unless the roadway capacity is increased. No parallel arterial exists which could assist in carrying the traffic load.

The section of Route 128 between Route 3 and Route 2 is an 8-lane expressway. In Plan A, Route 3 extends inside Route 128 to the interchange with Route 2 near Watertown Street in Lexington. This extension is the principal factor in the reduction in volume on Route 128 from 149,000 vehicles per day in Plan C to 111,000 in Plan A. The volume in Plan C approaches the capacity of the expressway; however, arterials crossing Route 128 that do not appear heavily loaded could provide some relief by attracting radially oriented travel away from Route 128.

Between Route 2 in Lexington and Route 20 in Waltham, Route 128 is built to eight lanes. The volumes under both plans range from 150,000 to 160,000 vehicles per day, slightly exceeding the capacity of the 8-lane expressway. Not included in the networks, however, are parallel connecting streets through industrial developments. These roads should be able to handle local traffic and reduce the volume on Route 128 somewhat, but probably not enough to eliminate the congestion that is likely to occur in this section.

The section of Route 128 from Route 20 in Waltham to the Massachusetts Turnpike in Weston is an 8-lane expressway. It is one of the most heavily loaded sections of Route 128. The projections for this section are from 180,000 to 190,000 vehicles per day, which exceed the capacity of the highway. Part of this volume can be attributed to the effect of the "T" intersection of the Western Expressway, which terminates at Route 128. With improvements to Routes 20 and 30, some of the radially oriented traffic may be diverted from Route 128. Even so, there will be a capacity problem on this highway.

Approximately 170,000 to 180,000 vehicles per day are forecast for Route 128 through the Massachusetts Turnpike/Route 30 interchange area, plus another 30,000 to 60,000 vehicles per day on access roads and ramp connections between the Turnpike, Route 128, and Route 30. These volumes approach or exceed the capacity of the facilities, and there is no reasonable way to expand the capacity.

Between the Massachusetts Turnpike in Weston and Route 9 in Wellesley, Route 128 carries an average volume of 173,000 vehicles per day in Plan A. The average volume in the Plan C network is about 156,000, which stretches the capacity of this 8-lane expressway. There are local streets, but none to which long-distance traffic might be diverted. Some of the inbound-oriented traffic might be diverted away from Route 128, but probably not enough to produce any drastic reduction of traffic on Route 128.

At the Route 9 interchange, Route 128 narrows from eight to six lanes and continues as six lanes to Route 109. A very poor merge situation occurs at the Route 9 interchange, with southbound traffic from Route 9 entering a section that has just narrowed from four lanes to three. This could become a critical bottleneck with the high volume forecast for 1990. The Plan A network volume of 135,000 vehicles per day exceeds the capacity of the expressway. The Plan C average volume of 115,000 vehicles per day could probably be carried by the existing facility under a very poor level of service. The fact that the Plan C volumes are lower than the Plan A volumes may be attributed to the extension of the Middle Circumferential in a full arc around Boston. Also, the proposed Route 209 expressway terminating at Route 128 draws inbound traffic from the west toward I-95 and away from this section of Route 128. However, with the capacity problem on I-95 previously mentioned, this diversion to I-95 might not actually develop and Route 128 traffic would probably be close to the Plan A forecast.

The section of Route 128 between Route 109 in Westwood and I-95 in Canton has six expressway lanes. In both networks, the highway is forecast to carry traffic considerably in excess of its present capacity. The average volumes are 145,000 vehicles per day in Plan A and 162,000 in Plan C. The difference in volume between the two plans results primarily from Route 209, which collects traffic from the west and distributes the majority of it towards the south. The possibility of upgrading existing Route 109 inbound from Route 128 to attract some of the radial traffic should be investigated.

Between I-95 in Canton and Route 24 in Randolph, Route 128 is a 6-lane expressway with forecast volumes greater than its capacity. The heaviest volumes occur near I-95, where they exceed 180,000 vehicles per day in both plans. Even eight lanes would not be sufficient to handle the forecast traffic.

The section from Route 24 in Randolph to the Southeast Expressway is eight lanes wide. The average volume in both plans is about 123,000 vehicles per day, which is well within the capacity of this highway. However, there is a problem caused by traffic entering from Route 37 in Braintree and weaving across the four lanes of Route 128 to exit left for the Southeast Expressway. This section presently has a number of accidents, and this record will probably continue unless this weave is restricted or diverted to a safer routing.

In summary, Route 128 has many sections which have 1990 projections higher than the road's capacity. Volumes of over 175,000 vehicles per day are projected in the Waltham-Weston-Newton-Wellesley area and the Westwood-Dedham-Canton area, with several other sections over 150,000. The tremendous unexpected development spawned by this highway's construction is a major factor contributing to its overloaded plight. Several sections of the roadway have already been widened, and projections indicate that even these sections will be inadequate by 1990. Since eight lanes is presently thought to be the maximum practical width for an expressway, some other means of providing relief to sections of Route 128 must be found. The only apparent hope of relieving Route 128 is a continuous circumferential highway close to Route 128 that is capable of providing a reasonable alternate route.

Middle Circumferential: In both the analysis networks, the Middle Circumferential has been proposed as a limited-access facility located between Route 128 and I-495. The primary objective of this expressway is to serve development in this area. This route would also supply a bypass around many congested town centers, while providing excellent accessibility from town to town. A secondary objective of this proposal is to provide an alternate routing for circumferential traffic, thereby lightening the traffic load on parallel arterial routes and on Route 128.

In Plan A, the Middle Circumferential extends from I-93 in Wilmington to Route 16 in Natick. This proposal is located primarily in the ring of towns adjacent to Route 128. Forecast traffic is about 25,000 vehicles per day near the I-93 terminus and about 20,000 vehicles per day at Route 16. Between these points, the volume ranges from 35,000 to 55,000 vehicles per day. Estimated traffic on parallel sections of Routes 27, 62, and 126 is less than 10,000 vehicles per day.

In Plan C, the Middle Circumferential makes an arc around Boston from I-95 in Boxford to Route 3 in Norwell. The proposal in this plan is located approximately midway between I-495 and Route 128. Across the northern half of the study area, between I-95 in Boxford and Route 20 in Sudbury, this route would in many locations relieve and replace the existing Route 62. The forecast volume range on this section is from 26,000 to 59,000 vehicles per day, with the heaviest volumes occurring east and west of Route 3 between Routes 4 and 3A in Billerica. Except for these two links, the volumes on the highway are less than 38,000 vehicles per day.

Across the southern half of the study area, between Route 20 in Sudbury and Route 3 in Norwell, the forecast traffic volume ranges from 30,000 to 89,000 vehicles per day. The majority of the link volumes are between 45,000 and 63,000 vehicles per day. The highest volume occurs between Route 24 and Route 28 north of Brockton, on a section used as a connector from Brockton to Route 24.

In both plans, the distribution of traffic among the radial corridors could probably be handled by a high-quality system of arterials between I-495 and Route 128. However, such a system does not presently exist and would be nearly impossible to build. Therefore, something else is needed.

To satisfy the objectives of serving development and providing an alternate route for circumferential traffic, it appears that a combination of the two alternate locations for a circumferential would be the best solution. The Plan A alignment gives the best access to the existing development centers of the larger cities and towns in the north and west portions of the Middle Circumferential Corridor, with the exception of Framingham. This alignment would serve Wellesley instead of Framingham. The Plan C alignment east of Route 24 is close to the development centers of Rockland and Holbrook and is reasonably close to Brockton. A connection between the circumferential terminus at Route 16 in Plan A and the Plan C location at Route 24 would also serve the development of Walpole, Sharon, Canton, and Stoughton. For purposes of system continuity, this arc should be completed on the northern end by a link to I-95 in Danvers.

In effect, the combination of the two alignments combines the development objectives of the two plans. This routing bypasses many town centers and should relieve many points of congestion on Routes 27, 62, and 126, as well as having a most beneficial effect in reducing the vehicle overload on Route 128.

TRANSIT

With several of the rapid transit lines extended to Route 128 or the Middle Circumferential, express bus service between these stations and major activity centers along these major circumferentials is possible. In addition to increasing the employment opportunities, such bus service would somewhat reduce the number of automobiles using Route 128 and the Middle Circumferential. Express bus service could also connect some of these activity centers with rapid transit lines that do not extend to Route 128.

Outer Circumferential Corridor

This outlying portion of the region is mostly rural-suburban in character, with some urban areas and industrial cities along its northern arc. This sector is expected to grow substantially when I-495 is completed, but probably not as fast or as extensively as the growth experienced along Route 128.

Partially completed Interstate Route 495 is the only major circumferential expressway that exists in this corridor. Circumferential rapid transit is not presently serving the area, nor is it expected to be necessary.

HIGHWAY

Interstate Route 495: When completed, I-495 will extend in an 88-mile arc between I-95 in Salisbury and I-95 in Foxborough. All sections of this route are either completed or under construction at the present time.

There are few pressing local traffic problems adjacent to I-495. Since the communities near its route are in most instances in the early stages of growth, they are able to direct their future expansion to harmonize with the location of the highway.

The highest forecast volume on I-495 between I-95 in Salisbury and Route 213 in Methuen is 80,000 vehicles per day in Plan A and 75,000 vehicles per day in Plan C. Between Route 213 and Route 3 in Chelmsford, the volume reaches 101,000 vehicles per day in Plan A, while the Plan C maximum is 85,000. The lower volumes in Plan C result from the extension of Route 213. If Route 213 is not extended, improvements will be necessary on Route 110, Route 113, or I-495.

The forecasts reveal that the most heavily utilized sections of I-495 will be in the Lowell-Lawrence area. However, with improvements to the alternate routes between the two cities and improvements in the vicinity of Lowell, the corridor should have ample capacity to accommodate the future demand.

The forecast volumes on I-495 between Route 3 in Chelmsford and I-95 in Foxborough can be accommodated by the six lanes built or under construction, although the 87,000 vehicles per day forecast in the vicinity of the Massachusetts Turnpike would strain the highway's capacity. South of the Turnpike, the forecast volumes on I-495 diminish, particularly in Plan C, because of the attraction of the Middle Circumferential and Route 209. It appears that no additional capacity is necessary.

An extension from I-495 in Foxborough to the junction of Routes 24 and 25 in Middleborough is currently under consideration by the Department of Public Works. It is expected that this will be an important recreational link to southeastern Massachusetts and Cape Cod. The extension would remove the "T" intersection at I-495 and I-95.

Route 213: The proposed extension of Route 213 is contained only in Plan C. It is a limited-access highway, connecting with the already improved Route 213 at I-93 in Methuen and continuing through Dracut and the western edge of Lowell to Route 3 in Chelmsford near the intersection of Route 4. Because of its continuity, the existing section of Route 213 between I-495 and I-93 carries from 6,000 to 11,000 more vehicles per day in Plan C than in Plan A. This difference in volume reflects a diversion of Lowell-oriented traffic from I-495 to Route 213.

The Route 213 extension appears to effect an average reduction of approximately 12,000 vehicles per day on I-495 between I-93 and Route 38, and about 18,000 vehicles per day on Route 38 north of I-495. It also substantially reduces traffic on Route 110 and the Lowell Connector south of the city. The volumes on Route 213 range from about 30,000 vehicles per day on either end to about 11,000 just north of Lowell. Screenlines indicate that about half of the traffic carried on the Route 213 extension is diverted from local streets and arterials and half from I-495.

There is no question that some relief must be provided to the city of Lowell to alleviate the present river crossing congestion. A bypass of Lowell from Route 113 on the east to Route 3 on the west is one possible solution. For travel from Lowell to Lawrence and points east, there appears to be sufficient corridor capacity, even though this demand would not be as well served without an extension of Route 213.

The extension of Route 213 as an expressway in the Lowell-Lawrence area is not warranted on the basis of estimated traffic volumes. The estimates do indicate a need for an additional bridge over the Merrimack River near Lowell and a new or improved arterial bypassing the city. Logical connecting points would be on Route 113 to the east and Route 3 to the west of the city. Area residents have been asking for some relief of this type in recent years.

Woonsocket Connector: The Woonsocket Connector would carry traffic from the urban area of Woonsocket, Rhode Island, through or around the abutting urbanized areas of Massachusetts to I-495 in Bellingham. This Connector is not contained in either alternative network but has been agreed upon by the two states.

Salisbury Beach Connector: The Salisbury Beach Connector, a spur from I-95 to Salisbury Beach, is not included in the alternative networks but has been given consideration by the Department of Public Works in recent months. Traffic volumes on roadways parallel to this proposed route indicate an average daily use of the new facility by fewer than 10,000 vehicles per day. Normally, only arterial improvements could be justified on this basis. It is doubtful whether recreational demand could justify a limited-access facility at this location.

CONCLUSIONS

One of the most significant aspects which is evident in the analysis of the alternative plans is the tremendous increase in highway travel in the future. Automobile ownership and highway travel will double by 1990. Neither plan is able to cope with this situation completely. The extent of future traffic congestion in some of the most heavily traveled corridors during peak morning and evening travel periods will depend upon the assistance provided by the transit system. Since an inordinate share of the region's real estate cannot be devoted to highways and parking lots, transit must be relied upon to carry a substantial portion of peak-period trips. Carrying the commuter has always been a principal function of the transit system, and this role must be expanded.

The analysis reveals that the Plan A highway system was deficient in several instances and the Plan C transit system was inadequate in many areas. A mixture of the better elements of the alternative plans appears necessary to serve the population's future travel desires.

VI. THE RECOMMENDED HIGHWAY AND TRANSIT PLAN

By 1990, substantial improvements and additions to the transportation system will be required to satisfy the growth in travel demand of a larger and more affluent regional population. The analysis of the forecast loadings on the alternative transportation networks described in Chapter V led to the selection of the recommended highway and transit plan (see Figure 12 on page 115).

The recommended network is primarily an expressway and rail rapid transit network, and the illustrations, costs, and priorities concern only these facilities. In selecting this system, however, the alternative transportation networks evaluated included important arterial and collector highways and major bus routes in the eastern Massachusetts region.

Although the arterial system of future highways and the feeder and express bus transit routes are not covered in detail in this report, they are important elements of the future travel picture and will require substantial improvement and expansion.

In considering the elements of the recommended transportation plan, the following points should be kept in mind:

- Locations of recommended facilities are intended to show corridors only. Nevertheless, rail rapid transit locations are fairly specific because of the proposed use of existing railroad rights-of-way. However, station locations are general.

- Rail rapid transit and expressway recommendations indicate only broad project needs and do not imply details of design.

FORM OF THE RECOMMENDED NETWORK

The proposed expressway system builds upon and strengthens the present radial and circumferential pattern, since analysis shows that this pattern will continue to serve the region best at the proposed development densities. It would be inadvisable to consider the adoption of some other basic pattern, since integration of the present system elements into any new pattern would be difficult. The pattern of growth and development of the region is heaviest in the center, with declining density outward from the core, consistent with the shape of a radial-circumferential system.

A major feature of the recommendations is the recognition of the need for both expressways and exclusive public transportation rights-of-way. It is clear from the testing process that sufficient highways cannot be built to accommodate all the peak-period travel.

The factors that prevent construction of adequate highway capacity are the amount of land required, the disruption of the inner suburbs and core area caused by construction of new facilities, and the storage requirements of vehicles at the ends of the trips. The rail rapid transit system, on the other hand, is well suited to serve high-density corridors, particularly the inner core, and plays a very important role by carrying a large share of the downtown commuters and by keeping the land-taking required for expressways and core parking facilities within tolerable limits. Nevertheless, it is also evident that everyone cannot be induced to use mass transportation. The recommended network, then, is a system of expressways and rail rapid transit lines designed to complement one another. Further study, which is already underway, will add such elements as major parking terminals to serve both the highway and transit elements.

BASIS OF SELECTION

The aim of the participation by the DPW and MBTA (with the aid of DCD and MAPC) in the Eastern Massachusetts Regional Planning Project has been the preparation of a comprehensive transportation development plan. Each recommendation included in the plan resulted from selective decisions based upon a knowledge of how each facility met the following list of criteria:

- Level of service. *The Highway Capacity Manual* (41) lists Levels of Service A through F. Level of Service E (traffic flow served under capacity operating conditions) was the minimum acceptable level allowed.

- Adequacy of existing facilities for carrying projected travel. The 1990 demand forecast for an existing rail rapid transit or expressway facility was compared with the existing capacity of that facility. If the capacity was exceeded, remedial action was recommended.

- Necessity of proposed facilities. The 1990 travel demand for a proposed facility was analyzed to determine whether the volume warranted a high-standard facility such as an expressway or rail rapid transit extension.

- Adequacy of proposed facilities. After establishing that a proposed facility was warranted, the forecast traffic volume was examined, taking into account practical design restrictions, to determine whether the facility would be adequate to carry the travel demand at an acceptable service level.

- Relief of present congestion. A factor in the selection of each facility in the recommended plan was how well the transportation system solved existing congestion problems. If the alternative proposals did not adequately solve existing congestion, recommendations were incorporated that would accomplish this objective.

- Expressway spacing. The Institute of Traffic Engineers has developed criteria for use in establishing the spacing between expressways. The *Design of Urban Freeways* (23) states guides for the distance between expressways as a function of the level of population density. These criteria were adhered to except where toll facilities were involved; expressways were allowed to be closer together under such a condition.

- Desires of the community. Community wishes regarding a proposed facility were taken into account in the development of the recommended system. Where opposition was voiced, acceptable alternatives were sought. Where no alternatives were found, there was no choice but to recommend the proposed facility in spite of public opposition.

- Access to important regional activity centers. Certain activity centers, such as employment concentrations and airports, deserve special treatment because of their importance to the growth of the region. Recreational areas, while not generating substantial amounts of travel on a daily basis, were included in the analyses based on present recreational demand experience.

- System continuity. Express facilities, whether highway or transit, should join with other facilities providing a comparable level of service to avoid overloading lower standard facilities. Expressways can be joined to form continuous networks; transit lines should either join other transit facilities or terminate at expressways.

- Cost. A rough cost of each proposed alternative was a factor in the rapid transit recommendations; however, the justification of some of the extensions will only be verified by further economic study. For the expressway system, cost was considered in evaluating alternative routes or the general location of an expressway in a corridor. Cost was also a factor in determining whether a project should be included in the short-range or the long-range program and whether the recommendations were economically feasible.

- Consistency with regional development goals and objectives. Each element of the transportation system was evaluated to ensure consistency with these goals and objectives. A complete list of goals and objectives is outlined in Chapter II.

SUMMARY OF RECOMMENDATIONS

A summary of committed projects and recommendations for expressway and rapid transit improvements follows. The recommendations have been divided into short-range (1968-1975) and long-range (1975-1990) programs. Long-range transit recommendations will require further feasibility studies.

Northeast Corridor

HIGHWAY

Committed Projects

- Construction of I-95 from Danvers to Revere; and
- Reconstruction of I-95 from Salisbury to Danvers.

Short-Range Program

- Upgrading of I-95 from Cutler Circle in Revere to the Tobin Bridge in Chelsea;
- Construction of the Beverly-Salem Connector; and
- Construction of the Revere Beach Connector.

Long-Range Program

- Construction of a New Harbor Crossing to East Boston from downtown Boston; and
- Construction of a Shore Expressway from the New Harbor Crossing to I-95 in Saugus.

A possible option is to shift the construction of the New Harbor Crossing from the long-range to the short-range program if some means of financing can be obtained.

TRANSIT

Committed Projects

- None.

Short-Range Program

- Short-term retention of rail commuter service; and
- Extension of Blue Line rapid transit to the Pines River and construction of a parking lot with a minimum of 2,500 spaces.

Long-Range Program

- Extension of the Blue Line to the Salem Connector;

- Improvement of downtown Blue Line distribution; and

- Construction of a branch to Logan Airport.

Northern Corridor

HIGHWAY

Committed Projects

- Completion of I-93 from Medford to the Inner Belt in Somerville; and

- Widening of the I-93 bridge over the Merrimack River between Andover and Methuen.

Short-Range Program

- No recommendations.

Long-Range Program

- No recommendations.

Options for the 1975-1990 period include widening Route 3 between I-495 and Route 128 and extending Route 3 from Route 128 to I-93.

TRANSIT

Committed Projects

- Construction of the Orange Line extension from Haymarket Station to Oak Grove in Malden; and

- Demolition of the existing Charlestown elevated structure.

Short-Range Program

- Short-term retention of railroad commuter service on both the Reading and New Hampshire Division lines, the former as long as Orange Line construction permits and the latter until an acceptable alternative is determined; and

- Retention of low-platform rail transit service to Lechmere until an alternative is established.

Long-Range Program

- Extension of the Orange Line rail rapid transit to Route 128;

- Construction of large parking facilities at Sullivan and Wellington stations; and

- Provision of express bus service to North Station via the Lechmere viaduct, replacing the low-platform rail transit service.

Northwest Corridor

HIGHWAY

Committed Projects

- Reconstruction of Route 2 from Route 128 in Lexington to Alewife Brook Parkway in Cambridge.

Short-Range Program

- Reconstruction of Route 2 from Route 111 in Acton to Route 128 in Lexington.

Long-Range Program

- Extension of Route 2 from Alewife Brook Parkway to the Inner Belt near the Cambridge-Somerville town line.

TRANSIT

Committed Projects

- Extension of the Red Line from Harvard Square to Alewife Brook Parkway.

Short-Range Program

- No recommendations.

Long-Range Program

- Extension of the Red Line from Alewife through Arlington Center and Lexington Center to a terminal at Route 128 in Lexington.

Western Corridor

HIGHWAY

Committed Projects

- Completion of I-290 from Northborough to Marlborough.

Short-Range Program

- No recommendations.

Long-Range Program

- Construction of the Western Expressway, an extension from I-290 at I-495 in Marlborough to Route 128 in Weston.

TRANSIT

Committed Projects

- None.

Short-Range Program

- Replacement of the existing Riverside rolling stock by new low-platform rail cars and the continuation of streetcar service on Beacon Street and Commonwealth Avenue.

Long-Range Program

- Through rapid transit service from downtown Boston to the proposed Middle Circumferential Expressway in the vicinity of the Wellesley-Natick line via high-platform service along the Riverside Line.

The use of the Penn Central Railroad right-of-way as an optional alternative to the Riverside Line routing is also being investigated.

Southwest Corridor

HIGHWAY

Committed Projects

- None.

Short-Range Program

- Completion of I-95 from Route 128 in Canton to the Central Artery in Boston.

Long-Range Program

- Construction of Route 209 from Route 146 in Uxibridge to Route 128 in Westwood.

TRANSIT

Committed Projects

- Relocation and extension of the Orange Line from the Tufts-New England Medical Center in the Back Bay to the VFW Parkway in Roxbury; and
- Demolition of the existing Orange-Line elevated structure to Forest Hills.

Short-Range Program

- Construction of the Orange Line to Route 128 in both Canton and Needham.

Long-Range Program

- No recommendations.

A long-range option, an extension of the Orange Line from Route 128 in Canton to the Middle Circumferential in the Sharon area, may be necessary to provide enough parking to meet the demand anticipated by 1990. An extension from Route 128 to Needham Junction also remains an option if the Needham area traffic grows sufficiently.

Southeast Corridor

HIGHWAY

Committed Projects

- None.

Short-Range Program

- Construction of the Hingham branch of the Hingham-Scituate Spur.

Long-Range Program

- Construction of the Shawmut Trail;
- Provision of additional capacity on the Southeast Expressway;
- Widening of Route 3 from Duxbury to Weymouth; and
- Construction of the Scituate Spur.

An option that should also be considered is a connection from the "T" intersection of Routes 24 and 128 to either Route 28 or Route 138.

TRANSIT

Committed Projects

- Construction of the South Shore Red Line from Andrew Station to South Braintree; and
- Upgrading of the Dorchester Red Line to high-platform rapid transit between Ashmont and Mattapan.

Short-Range Program

- No recommendations.

Long-Range Program

- Extension of the Red Line along Route 3 from South Braintree to South Weymouth; and
- Provision of additional parking at the stations along the Mattapan extension.

Options in the long-range program include a further extension along Route 3 to the Middle Circumferential and a branch extension to Brockton.

Regional Center

HIGHWAY

Committed Projects

- None.

Short-Range Program

- Construction of the Inner Belt; and
- Upgrading of the Central Artery.

Long-Range Program

- Construction of the approaches to the New Harbor Crossing from the Inner Belt and Southeast Expressway.

TRANSIT

Committed Projects

- None.

Short-Range Program

- Relocation of the Orange Line to provide direct access to the Back Bay.

Long-Range Program

- Construction of a new downtown subway tunnel allowing through Blue Line transit service linking the North Shore with the western suburbs; and

- Construction of downtown bus terminals and a downtown surface transit system to support the subway system and the bus terminals.

Middle Circumferential Corridor

HIGHWAY

Committed Projects

- None.

Short-Range Program

- Upgrading of Route 128 from Lynnfield to Beverly.

Long-Range Program

- Construction of a Middle Circumferential Expressway from I-95 in Danvers to Route 3 in Norwell; and

- Upgrading of Route 128 from Beverly to Gloucester.

TRANSIT

Committed Projects

- None.

Short-Range Program

- No recommendations.

Long-Range Program

- No recommendations.

Outer Circumferential Corridor

HIGHWAY

Committed Projects

- Completion of the southern segment of I-495, forming a continuous expressway from I-95 in Salisbury to I-95 in Foxborough.

Short-Range Program

- No recommendations.

Long-Range Program

- Construction of a connector from I-495 in Bellingham to the urbanized area of Woonsocket, Rhode Island.

TRANSIT

Committed Projects

- None.

Short-Range Program

- No recommendations.

Long-Range Program

- No recommendations.

PRIORITIES AND CAPITAL COSTS

The comprehensive transportation recommendations contained in this report are designed to accommodate the travel demand in the eastern Massachusetts region in 1990. In addition to the projects already committed for construction (see Table 5), a number of the recommended highway and transit improvements have been identified as high-priority projects. These projects should be constructed during the period 1968-1975 (see Table 6). The other projects should be completed in the period 1975-1990 (see Table 7).

The priority tables also list the length in miles, the total capital cost in 1968 dollars, and the anticipated federal and state (including public authority) shares of the expenditures. The estimated capital outlay includes construction, right-of-way acquisition, and engineering. It does not include maintenance, traffic or operating services, or miscellaneous overhead. Mileages and costs for the short- and long-range programs are summarized in Table 8.

The capital cost estimates for highways are based on the 1968 estimate of the cost to complete the Interstate Highway System (42), low bids on projects already advertised for construction, or comparison with the cost of similar projects constructed in recent years in similar physical environments. Transit costs are based on current experience with the South Shore extension and other capital projects.

Highways

Committed highway projects include 74.0 miles of new and upgraded expressways. These committed projects will cost $235,163,000. Only $38,478,000 is allocated to non-Interstate facilities.

A total of 62.3 miles of expressway construction and upgrading is recommended for the 1968-1975 program. Of this mileage, 21.9 miles are part of the Interstate Highway System. Highways in the Interstate System are eligible for 90 percent financial assistance from the Federal Highway Trust Fund. The total cost of construction of the Interstate portion of the 1968-1975 highway program is estimated at $455.1 million. The federal share will amount to $409.6 million. The two most important and costly facilities are the Inner Belt (I-695) and the extension of I-95 from Route 128 in Canton to the Central Artery.

The remaining 40.4 miles of expressway facilities recommended for construction or upgrading during 1968-1975 fall under a funding arrangement called the ABC program, which means that the State and Federal Governments share the cost equally. The most critical cost items are the ABC-funded roads. The Commonwealth receives an average of $15 million annually in ABC funds from the Federal Government for the entire state. If federal aid programs are not expanded, a total of $105 million would be available for the 7-year program. When matched with state funds from highway user revenues, principally the gasoline tax, a total of $210 million will be available. Not all of this money, of course, can be allocated to eastern Massachusetts. Therefore, the projects contained in the 1968-1975 program have been carefully selected. The recommended ABC highway projects will cost an estimated $75.9 million.

Implementation of the 1975-1990 highway program of construction or upgrading of 186.9 miles of expressways will cost $580.3 million. All funding is based on the current ABC 50-50 matching ratio, since the Interstate System is scheduled for completion before 1975. If the Federal Government increases its percentage of ABC funds, the construction of ABC facilities could be accelerated and more of the options identified could be considered.

Table 5
COMMITTED PROJECTS

Expressway	Length (Miles)	Federal Aid	State Funds	Total To Be Funded	Total
		(Thousands of Dollars)			
I-495 Westborough–Foxborough	26.1	38,790	4,310	0	43,100
I-290 Northborough–Marlborough	5.6	12,060	1,340	0	13,400
I-95 Danvers–Revere	13.4	71,087	7,898	0	78,985
I-95 Salisbury–Danvers	20.7[a]	27,450	3,050	0	30,500
I-93 Medford–Somerville	2.0	24,300	2,700	0	27,000
I-93 Methuen–Andover	0.2[a]	3,330	370	0	3,700
Route 2 Lexington–Arlington	6.0[a]	19,239	19,239	0	38,478
Subtotal	47.1 26.9[a]	196,256	38,907	0	235,163

Rail Rapid Transit	Length (Miles)	Federal Aid	MBTA Bonds	Total To Be Funded	Total
Orange Line Haymarket–Oak Grove	6.0	68,300[b]	40,900	0	109,200
Orange Line Back Bay–VFW Parkway	8.6	53,000	37,400	0	90,400
Red Line Harvard–Alewife	2.5	55,000[b]	35,000	31,100	90,000
Red Line Andrew Square–Braintree	8.5	32,300	51,800	0	84,100
Red Line Mattapan	2.0[a]	0	7,800	5,000[c]	12,800
Subtotal	25.6 2.0[a]	208,600[b]	172,900	36,100	386,500
TOTAL COMMITTED HIGHWAY AND TRANSIT PROJECTS		404,856	211,807	36,100	621,663

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[a] Upgrading of facilities.
[b] Includes money from federal sources other than federal transit grants.
[c] Money available from sale of Bennett-Eliot Yards.

Table 6

SHORT-RANGE PROGRAM COSTS
1968–1975

		(Thousands of Dollars)			
Expressway	Length (Miles)	Federal Aid	State Funds	Total To Be Funded	Total
I-695 Somerville–Boston	5.5	192,600	21,400	214,000	214,000
I-95 Canton–Boston	10.0	143,192	15,910	159,102	159,102
I-95 Revere–Chelsea	3.8[a]	19,800	2,200	22,000	22,000
I-95 Central Artery–Boston	2.6[a]	54,000	6,000	60,000	60,000
Beverly–Salem Connector	8.1	14,000	14,000	28,000	28,000
Hingham Spur	8.0	4,000	4,000	8,000	8,000
Revere Beach Connector	1.5	1,250	1,250	2,500	2,500
Route 2 Acton–Lexington	12.0[a]	12,550	12,550	25,100	25,100
Route 128 Lynnfield–Beverly	10.8[a]	6,130	6,130	12,260	12,260
Subtotal	33.1 29.2[a]	447,522	83,440	530,962	530,962

Rail Rapid Transit	Length (Miles	Federal Aid	MBTA Bonds	Total To Be Funded	Total
Orange Line Forest Hills–Route 128	6.0	0	30,000	30,000	30,000
Orange Line VFW Parkway–Route 128	1.5	0	7,000	2,000	7,000
Blue Line Wonderland–Pines River	1.5	0	9,000	9,000	9,000
Subtotal	9.0	0	46,000	41,000	46,000
TOTAL SHORT-RANGE HIGHWAY AND TRANSIT		447,522	129,440	571,962	576,962

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[a] Upgrading of facilities.

Table 7

LONG-RANGE PROGRAM COSTS
1975-1990

		(Thousands of Dollars)			
Expressway	Length (Miles)	Federal Aid	State Funds	Total To Be Funded	Total
Middle Circumferential Danvers–Norwell	66.0	85,500	85,500	171,000	171,000
Southern Connection to New Harbor Crossing Boston	0.6	11,500	11,500	23,000	23,000
Shore Expressway East Boston–Saugus	4.7	9,500	9,500	19,000	19,000
New Harbor Crossing Boston	2.9	0	144,000	144,000	144,000
Western Expressway Marlborough–Weston	17.8	15,000	15,000	30,000	30,000
Southeast Expressway Braintree–Boston	8.6[a]	8,250	8,250	16,500	16,500
Shawmut Trail Hingham–Braintree	8.6	15,500	15,500	31,000	31,000
Scituate Spur	4.0	2,000	2,000	4,000	4,000
Woonsocket Connector Bellingham	7.5	3,050	3,050	6,100	6,100
Route 2 Arlington–Somerville	4.0	45,000	45,000	90,000	90,000
Route 3 Duxbury–Weymouth	19.0[a]	5,000	5,000	10,000	10,000
Route 128 Gloucester–Beverly	13.2[a]	2,870	2,870	5,740	5,740
Route 209 Uxbridge–Dedham	30.0	15,000	15,000	30,000	30,000
Subtotal	146.1 40.8[a]	218,170	362,170	580,340	580,340

		(Thousands of Dollars)			
Rail Rapid Transit	Length (Miles)	Federal Aid	MBTA Bonds	Total To Be Funded	Total
Blue Line Pines River–Salem Connector	5.5	30,600	15,400	46,000	46,000
Blue Line Airport Branch	1.0	8,000	4,000	12,000	12,000
Blue Line Downtown Connection	1.0	26,700	13,300	40,000	40,000
Blue Line Riverside	11.0[a]	29,300	14,700	44,000	44,000
Blue Line Riverside–Middle Circumferential (Natick–Wellesley)	5.0	20,000	10,000	30,000	30,000
Orange Line Oak Grove–Route 128 (Wakefield)	6.0	36,000	18,000	54,000	54,000
Red Line Alewife–Route 128 (Lexington)	8.0	41,600	20,800	62,400	62,400
Red Line South Braintree–South Weymouth	3.0	16,000	8,000	24,000	24,000
Subtotal	29.5 11.0[a]	208,200	104,200	312,400	312,400
TOTAL LONG-RANGE HIGHWAY AND TRANSIT		426,370	466,370	892,740	892,740

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[a] Upgrading of facilities.

Table 8

TOTAL COSTS FOR SHORT- AND LONG-RANGE PROGRAMS

		(Thousands of Dollars)			
1968-1975	Length (Miles)	Federal Aid	State Funds or MBTA Bonds	Total To Be Funded	Total
Expressway	33.1 29.2[a]	447,522	83,440	530,962	530,962
Rapid Transit	9.0	0	46,000	41,000	46,000
Subtotal		447,522	129,440	571,962	576,962
1975-1990					
Expressway	146.1 40.8[a]	218,170	362,170	580,340	580,340
Rapid Transit	29.5 11.0[a]	208,200	104,200	312,400	312,400
Subtotal		426,370	466,370	892,740	892,740
Total Expressway	179.2 70.0[a]	665,692	445,610	1,111,302	1,111,302
Total Transit	38.5 11.0[a]	208,200	150,200	353,400	358,400
TOTAL SHORT- AND LONG-RANGE PROGRAMS		873,892	595,810	1,464,702	1,469,702

[a] Upgrading of facilities.

Rail Rapid Transit

A total of 25.6 miles of new rail rapid transit lines and 2.0 miles of upgraded lines are presently committed by the MBTA for construction. Construction is well along on two extensions, the Red Line from Andrew to South Braintree and the Orange Line from Haymarket to Oak Grove. Construction of a third extension, the Orange Line from Kneeland Street to West Roxbury, depends on construction of I-95 from Canton to Boston, since the proposed transit line runs in the median strip.

Construction costs for the committed and short-range projects in the recommended transit system amount to $432.5 million. This total includes the projects tested, evaluated, and recommended by the EMRPP and the Mattapan project proposed by the MBTA. It is expected that $208.6 million will be obtained from federal mass transit grants and other sources, such as urban renewal funds. (The MBTA also expects to realize $5.0 million from the sale of the Bennett-Eliot Yards.) Federal mass transit funds are assumed to be available at the rate of $17.5 million per year to 1975. Unless additional federal grants are received for proposed extensions on the Blue Line from

Wonderland to Pines River and on the Orange Line from West Roxbury to Route 128 and from Forest Hills to Route 128, $218.9 million would have to be provided from the sale of MBTA bonds.

The MBTA presently has a bonding limitation of $225 million. In addition to the rail rapid transit projects that have been tested and evaluated by EMRPP, the MBTA *Program for Mass Transportation* includes other projects that must be funded from this money. These projects include improvements to the central subway system; station modernization; improvements to existing plants, yards, shops, and garages; replacement of rolling stock; and subsidization of railroad commuter service.

It is clear that the bonding authority of the MBTA will have to be expanded to obtain adequate funds for completion of the short-range program and for the purchase of equipment and the construction and improvements to other facilities necessary during the 1968-1975 period. The revised MBTA *Program for Mass Transportation,* to be completed in January 1969, will contain an estimate of the additional bonding authority that must be sought from the legislature.

The long-range program includes 29.5 miles of new transit construction and 11.0 miles of upgrading at a cost of $312.4 million. It is estimated that the two-thirds federal funding available to the MBTA will total $208.2 million. If all of these extensions and improvements prove feasible, the MBTA would need $104.2 million from the sale of bonds.

IMPLICATIONS OF THE RECOMMENDED NETWORK

Community Aspects

A transportation system can have beneficial or adverse effects on the general character of a community. How beneficial these transportation facilities are depends upon the extent to which they are coordinated with community plans and programs. A highway, if properly utilized, can be an effective means for improving the use of land or restructuring the city. The effects of the system components must be carefully considered so that undesirable land uses do not emerge which might defeat the transportation objectives.

As with any plan that involves taking substantial amounts of land, hardships will be incurred. People living in the path of a planned highway must face the problems of relocating their homes. To them, the highway program may mean considerable inconvenience and expense. Businesses located in the proposed highway right-of-way are confronted with the same prospect. Much progress has been made in ameliorating the results of dislocation, and the Department of Public Works is working with other agencies toward liberalizing the relocation payments authorized. It is recommended that legislation be prepared to bring these payments more in line with the needs of the people and businesses dislodged.

The apparent hardships and inconveniences can sometimes be used to the advantage of the individual and the community. The necessity of moving provides the opportunity to find a better place to live and to improve one's environment if sufficient resources are available.

Businesses that relocate often find more accessible locations for suppliers and consumers because of the very transportation system that forced the relocation. However, marginal enterprises are sometimes forced out of business. This condition could often be avoided if sufficient allowance for relocation were provided.

Bisecting a community with a highway can also work toward the betterment of the community, if this division can be used to preserve homogeneous areas or to separate dissimilar land uses, such as residential and industrial areas. The advantages and opportunities provided by new expressways far outweigh the disadvantages. If highways are properly integrated with urban planning, they can be used to help renew slum areas or demolish undesirable structures. It has been estimated that at least 50 percent of the households that would be displaced in Boston by the Inner Belt would be displaced by public action in any event, and many of the businesses would probably also be displaced by urban renewal. The Inner Belt presents an excellent opportunity for revitalizing the areas of Boston, Brookline, Cambridge, and Somerville through which it passes.

The Inner Belt also provides the chance to seek new and bold uses of the joint development concept to achieve maximum use of the urban land devoted to transportation. Air rights over expressways are being utilized more frequently. Apartment houses, hotels, office buildings, and parking lots are being developed over or around expressways. In heavily built-up areas through which expressways pass, apartment buildings can provide housing for displaced residents in one-third the space required by row housing. The space saved can be utilized for many desirable objectives. With careful planning, replacement housing can be provided as construction proceeds. When integrated with urban renewal or model cities programs, the highway would not be considered an intruder but a welcome component of the city. It is recommended that the Department of Public Works be empowered to expend highway funds on joint development work consistent with the Department's overall objectives.

The benefits of new expressways are not confined to the cities. Construction of highways in suburban areas has allowed rapid expansion of residential and commercial activities. Many communities have resisted industrial development because of the influx of noise, smoke, and low-income workers and because of the demand for additional schools and other public services. However, several eastern Massachusetts communities that have reluctantly permitted industrial development have realized substantial benefits. Many towns along Route 128 have experienced a greater rise in land valuation, in both old and new residential areas, than could be accounted for by any reason other than industrial development. The same effect is now being felt in towns along I-495. The industrial park has also been a significant factor in reducing resistance to industrial complexes, because these parks are neat and clean and are separated from residential areas where possible.

Highway improvements also have the advantage of reducing travel time to work, shopping, social-recreational, and other activities. By making travel easier between residential areas and employment centers and by inducing commercial and industrial activity, new freeways expand the employment opportunities accessible from any one location, thus providing a number of economic benefits for employers and potential employees.

Well-run transit systems are almost entirely beneficial to a metropolitan area. They provide a means of transportation for those who cannot afford automobiles or taxis and for those who cannot or do not choose to drive an automobile. Of prime importance is the number of vehicles removed from the highway system during peak commuting hours. In addition, improved transit is perhaps the only salvation of the central areas of large cities. Without transit service, downtown renewal would fail because of traffic strangulation. Transit can also be a weapon in the war on poverty, a means of linking disadvantaged neighborhoods with employment centers.

The prime disadvantage of transit systems is that they often represent deficit operations which must be subsidized by the area residents served. However, transit serves a necessary function in the metropolitan area and probably should be subsidized, as are other forms of transportation.

Almost all of the rapid transit improvements contained in the recommended plan are located underground or along existing railroad rights-of-way. The community disruption precipitated by the transit construction will be minimal and temporary, for the most part. The demolition of all the existing elevated track will eliminate a public eyesore and one cause of blighted neighborhoods.

Planning Aspects

The increased transportation accessibility created by the implementation of the recommendations should be a catalyst for new development throughout the region. It may also furnish the stimulus for the rehabilitation of older areas, as it has in Somerville. The new transportation construction provides the opportunity for bold new ideas for multiple use of rights-of-way. However, unless this development is carefully planned, the transportation system may have harmful effects in areas subject to its influence. The attractiveness of land adjacent to the transportation system would normally result in undesirable high-density clustering of commercial, residential, or industrial uses. Just as residential development near expressway interchanges prevents a more effective use of this prime land, so may commercial and industrial development prevent easy access from residential areas to transit stations.

Control of land use through zoning or other means can at least prohibit certain objectionable uses, even if it cannot force development to occur in a desired way. This control does exert a strong influence. Guidelines for the control of land use near expressways have been developed by the Director of the Bureau of Transportation Planning and Development and are currently being circulated.

Transportation planning and design must be a joint venture between local and state governments in conjunction with regional planning agencies. The planning process should be concerned with shaping the region and its transportation facilities into a balanced and integrated system with consideration given to community desires, safety, convenience, beauty, and economic impact. Insistence on a high level of aesthetic quality and the encouragement of integration of transportation facilities with urban improvements will help develop public support.

Since zoning ordinances and building applications are approved by the local communities, they must be warned of the consequences of these policies. The responsibility for advising the communities on planning matters should rest with the five regional planning agencies that have jurisdiction in the region. The regional agencies have professional staffs, which local groups do not have, and can give the communities capable guidance in such matters as maintaining reasonable densities of residential activities and promoting orderly development of industrial areas. The interchange of ideas between the local communities and the regional planning agencies must be maintained and the alliance between them strengthened for the communities' benefit and for the benefit of the region as a whole.

VII. CONTINUING TRANSPORTATION PLANNING

The transportation planning recommendations of the Eastern Massachusetts Regional Planning Project constitute both a long-range plan for a transportation system, based on the region's anticipated growth for more than 20 years in the future, and a short-range program aimed at the next crucial 7 years. This report is the result of several years' effort by the EMRPP staff, who had the benefit of review and comment solicited from elected public officials, planning agencies, and many others.

Accomplishment of the transportation plan will require the separate government entities involved to work together. Healthy discussion and early agreement on the recommendations and the development of coordinated programs for their financing and accomplishment will do much to preserve valuable features of the region as well as foster the overall development and growth of the area. Planning, therefore, must not produce static documents, but vibrant, current guides to a better region. This spirit is intended to characterize this report.

The Bureau of Transportation Planning and Development of the DPW is responsible under law for the continual preparation of comprehensive and coordinated transportation plans and programs throughout the state. Regional planning agencies direct their efforts to overall planning for the development of their local regions. However, the agencies are vitally interested in transportation plans as they relate to the development of the region. Therefore, the agencies are encouraged to review and comment upon transportation plans within their regions.

Regional development planning for the future depends in large measure on accurate forecasts of socioeconomic data that regional agencies usually gather and update as circumstances demand. Many of these projections are also necessary for the development and updating of future transportation plans. In the interest of efficiency and cooperative planning, it is important that close interaction between the transportation planning process and the continuing regional development activities of the planning agencies be maintained. The Department of Public Works, through its Bureau of Transportation Planning and Development, will work cooperatively with the planning agencies in the continuing transportation planning process.

SUBDIVISION OF THE AREA

It is difficult to collect and process data for areas as large as eastern Massachusetts. For the continuing planning process, it is anticipated that the area will be subdivided to provide for greater refinement of analysis. It is expected that this will permit closer scrutiny of the conditions on arterials and connecting roads, particularly in the metropolitan areas.

Within the eastern Massachusetts region, there are four metropolitan areas as defined by the U.S. Bureau of the Budget. These four areas are now served by the following planning agencies:

- Metropolitan Area Planning Council (Boston)
- Central Merrimack Valley Regional Planning Council (Lawrence-Haverhill)
- Old Colony Planning Council (Brockton)
- Greater Lowell Area Regional Planning Council (Lowell)

Several towns on the west side of the region are located in the Central Massachusetts Regional Planning District and the Montachusett Regional Planning District. A map of the eastern Massachusetts region, indicating the planning districts, is shown in Figure 13.

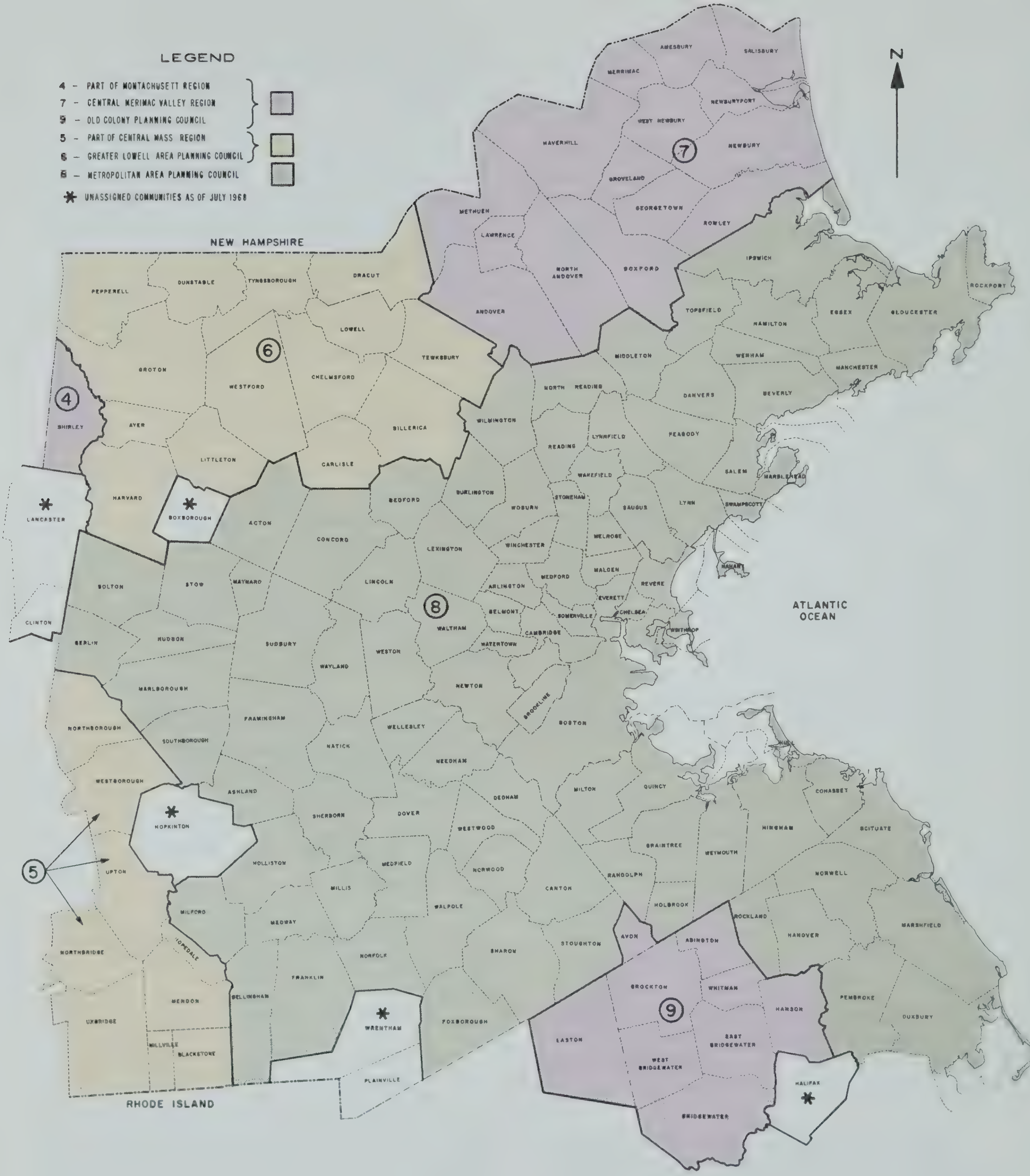

FIGURE 13

PLANNING DISTRICTS WITHIN THE EASTERN MASSACHUSETTS REGION

AS OF JULY 1968

ABOVE TAKEN FROM PLANNING REGIONS IN MASSACHUSETTS
AS PREPARED BY MASSACHUSETTS DEPARTMENT OF
COMMERCE AND DEVELOPMENT

The minimizing of conflicts within planning districts, especially in federally aided projects, is the responsibility of these planning agencies under the provisions of Section 204 of the 1966 Federal Demonstration Cities and Metropolitan Development Act. The acceptance of a long-range highway and mass transit plan that is coordinated with the other elements of an adequate regional plan will provide an excellent base for the early resolution of conflicts. Strong consideration should be given to the suggestion that the planning sections of the operating transportation agencies assume the responsibility for processing Section 204 referrals through the planning agencies, including early review of prospective projects.

DIVISION OF DUTIES AND SCHEDULES OF UPDATING

General guidelines for the "Operations Plans for Continuing Urban Transportation Planning" were issued in May 1968 by the Bureau of Public Roads. Certain information that is normally furnished by planning agencies was required in the production of the transportation plan and will be needed for the continuing planning process. It is necessary that interagency agreements be made between the planning agencies and the Department of Public Works for a clear understanding of the division of responsibility and the frequency of updating. It would be the responsibility of the Director of the Bureau of Transportation Planning and Development to initiate joint annual review to prepare for the updating of the transportation plan.

The interagency agreement for the Metropolitan Boston area will require the continued effective participation of the Massachusetts Bay Transportation Authority because of the extreme importance of the transit system.

Continuing discussion with public officials is a primary part of the continuing planning process, which provides for testing, adjusting, and updating the plan as necessary to keep in tune with new developments and be continually refocused on the region's most desirable development.

COORDINATION WITH LOCAL OFFICIALS

Early in the studies of the eastern Massachusetts region, contact was made with the local communities to outline the study program and to receive suggestions. This was done through 18 transportation coordinating committees, as well as regional agencies and local governing bodies and planning boards. The transportation coordinating committees were established through memoranda of understanding signed by the communities and the Department of Public Works.

Now that a recommended plan has been prepared, it should be presented to the local communities. In the continuing planning process, modifications will undoubtedly be suggested and will require evaluation. For future effective coordination, review and comment should continue to be sought from elected officials and local and regional planning groups. DPW personnel in the Department's district offices will continue to provide local contact with these groups for the Bureau of Transportation Planning and Development.

In each regional planning district, the DPW, the planning agency, and representatives of local governing bodies will devise effective means for continuing the functions initially assumed by the transportation coordinating committees. As a result, modifications to the existing memoranda of understanding may be required.

TRANSPORTATION PLANNING CENTER

A statewide Transportation Planning Center has been established in Boston under an interagency agreement. The center is currently staffed by the Massachusetts Department of Public Works Bureau of Transportation Planning and Development, with financing by planning and research funds of the Department of Public Works and the Bureau of Public Roads. Chapter 563 of the Acts of 1964 provides that:

> Said bureau shall serve as the principal source of transportation planning in the Commonwealth, and in so serving shall conduct

> research, surveys, demonstration projects and studies in cooperation with the federal government, other governmental agencies, and appropriate private organizations and be responsible for the continual preparation of comprehensive and coordinated transportation plans and programs for submission to and adoption by the commission and for such review of considerations by other governmental agencies as may be required by law or deemed appropriate by the commission. Said plans and programs shall be prepared in coordination with comprehensive urban development plans and in cooperation with the said other agencies so far as practicable.

The Transportation Planning Center staff must provide the skills for carrying out transportation planning. Today's transportation planning process is a relatively new development of the last 15 years. It requires specially trained and highly qualified planning engineers, who are in scarce supply because of the demanding needs of expanding transportation systems. The staff must be ever alert for methods to refine and sharpen the process of analysis and forecasting of the data required to update the transportation system in the continuing planning process.

AREA MONITORS

Outside the region covered by this report, five other urban area transportation studies in the Commonwealth are being completed by private consulting firms engaged by the Bureau of Transportation Planning and Development (see Figure 14). These projects are under the supervision of monitors from the Bureau, who are based at the Transportation Planning Center in Boston. These monitors provide liaison within the DPW, with the regional planning agencies, with federal and state agencies, and with the transportation coordinating committees.

As discussed previously, the eastern Massachusetts region will be divided into smaller sections to coincide with the areas served by the regional planning agencies. The monitors, working with the DPW district highway personnel, will keep the agencies informed of all urban transportation planning. In turn, the planning agencies can inform the Bureau of Transportation Planning of their development plans through the same monitors. Desirable and necessary cooperation is thus promoted to the mutual benefit of these two important planning groups.

MAJOR TASKS TO BE ACCOMPLISHED

Yearly goals for the continuing planning process should be established for both the Transportation Planning Center and for each planning district. The process must be concerned with testing and updating both the long- and short-range plans, based on actual and potential changing economic factors and/or desires. The recommended plan for the region must be tested for traffic loading.

Any elements of the Eastern Massachusetts Regional Planning Project study that supplement the major objective of a soundly developed transportation plan must be completed. The Bureau of Public Roads has recognized that the complexity of problems faced by the various studies throughout the country has not permitted completion of all study projects in final form.

One of these projects is the establishment of an interagency policy for the future provision of parking facilities within the Boston area and at appropriate locations adjacent to transit facilities. Also, there must be coordination with the region's recommended plan and the 1969 MBTA program that is to be presented to the legislature. In addition, two major tasks to be undertaken for the Inner Belt will require detailed analysis and study to assist in the resolution of current conflicting opinions.

The continuing planning process must provide within the study area more and smaller traffic zones and include in the analysis process more local roads to obtain greater refinement of traffic

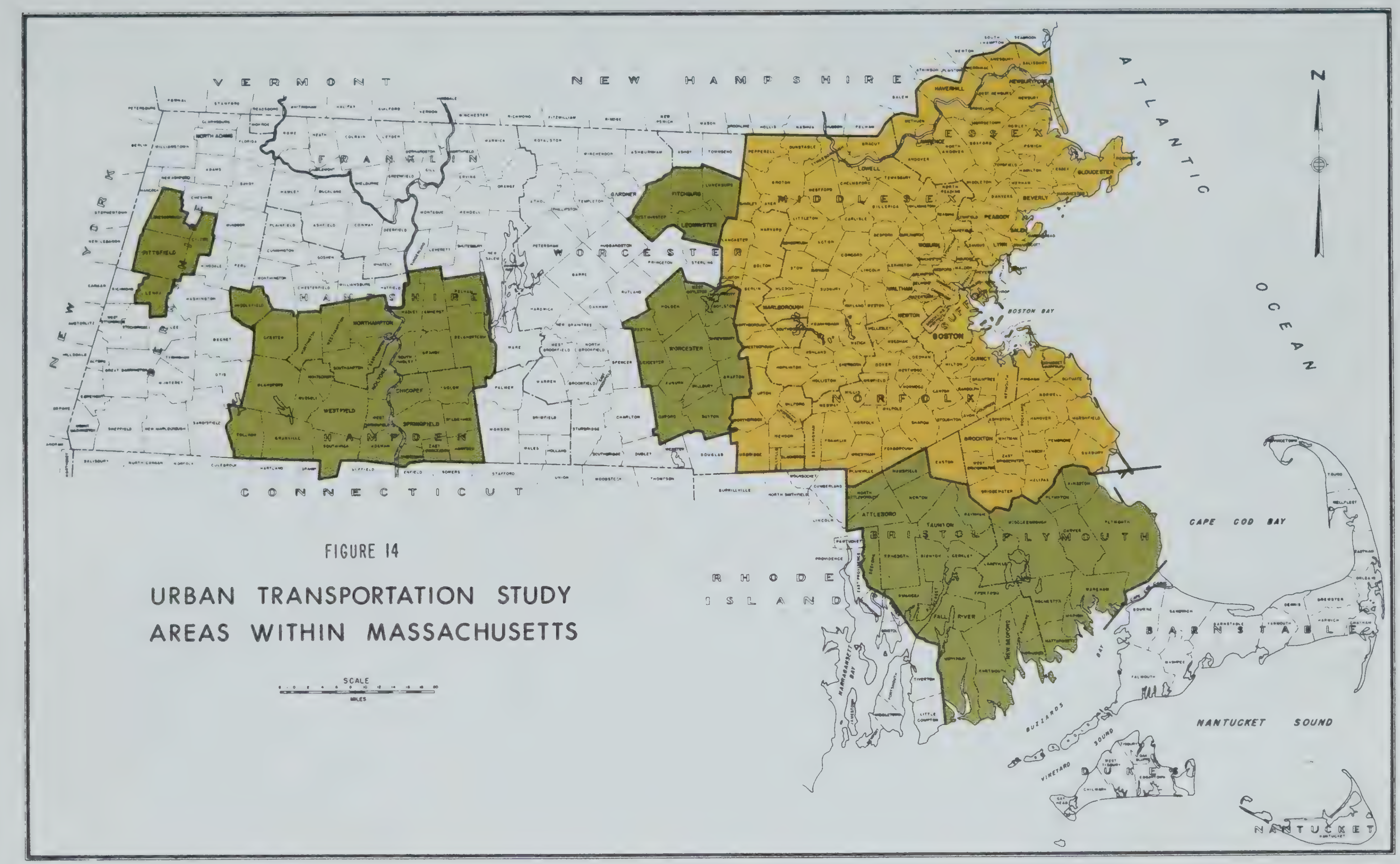

FIGURE 14

URBAN TRANSPORTATION STUDY
AREAS WITHIN MASSACHUSETTS

distribution. The demands by highway designers for future traffic estimates are continually increasing; alternative proposals submitted by highway and transit designers or developed by the Center staff must continue to be tested. To provide such capabilities, both an adequate staff and computer resources must be maintained.

The process must also be concerned with improving the technical and research methods employed. Research is needed into the basic methods used in the mathematical procedure for determining the relative usage of transit and highway systems. To develop improvements, field research should be undertaken to obtain more knowledge of trip generation at specific areas of high concentration, such as shopping centers. Collection of trip generation data and the development of mathematical trip equations must be improved. As a result, improvements in the process by which the planner establishes peak-hour assignments can be anticipated.

Another major research task of the Transportation Planning Center concerns methods of making traffic assignments with capacity restraints and making detailed studies of specific problems within the network. These methods must be developed and refined for more rapid solution of complex problems.

The continuing process will include the preparation and dissemination of such documents as the recently drafted *A Recommended Guide for Land Use Planning With Emphasis on Expressway Interchanges.* Such a guide should be helpful in overcoming indiscriminate land development around expressway interchanges that unduly restricts the usefulness and safety of the interchanges.

The transportation systems of all six urban area studies must be integrated into a statewide transportation network. Concurrently, work will continue on the statewide study on Highway Classification, Needs, and Fiscal Requirements, which is now being carried on by the Bureau of Transportation Planning and Development.

The above tasks are only samples of the work that must be done. The necessary accomplishment of these tasks in the development of a balanced statewide transportation plan is a monumental undertaking.

Excellent transportation systems have been developed in the past and sound engineering judgment has been used. However, the complex structure of a region in today's modern world requires a deeper and broader look into the future than has been permitted by past techniques. The cooperation of the informed representatives of the many governing bodies will continue to contribute much to the successful realization of a comprehensive highway and transit system.

APPENDIX A

COMMONWEALTH OF MASSACHUSETTS INTER-AGENCY AGREEMENT FOR THE PURPOSE OF CONDUCTING A COMPREHENSIVE COOPERATIVE TRANSPORTATION PLANNING PROCESS FOR EASTERN MASSACHUSETTS

AGREEMENT made as of the 17th day of September 1965, by and between the DEPARTMENT OF COMMERCE AND DEVELOPMENT, (hereinafter called the "DCD"); the DEPARTMENT OF PUBLIC WORKS, (hereinafter called the "DPW); the METROPOLITAN AREA PLANNING COUNCIL (hereinafter called the "MAPC"); and the MASSACHUSETTS BAY TRANSPORTATION AUTHORITY (hereinafter called the "MBTA"); all of the COMMONWEALTH OF MASSACHUSETTS; being hereinafter collectively referred to as the "Agencies."

WHEREAS, a November 30, 1962 Inter-Agency Agreement, as amended on February 26, 1964 and October 30, 1964 (hereinafter called the "1962 Agreement") was executed for the purpose of the DPW and the DCD undertaking jointly to produce a comprehensive regional plan and development program for 152 cities and towns in eastern Massachusetts (hereinafter called the "planning area"), with special emphasis on the region's transportation needs, with the assistance of funds from the Federal Housing and Home Finance Agency (hereinafter called the "HHFA") and the United States Department of Commerce, Bureau of Public Roads, (hereinafter called the "BPR"); and

WHEREAS, since the initial execution of the 1962 Agreement a Bureau of Transportation Planning and Development has been created within the DPW by Chapter 563 of the Acts of 1964 which serves as the principal source of transportation planning in the Commonwealth; and

WHEREAS, since the initial execution of the 1962 Agreement a Bureau of Area Planning has been created within the Division of Planning of the DCD which shall serve as the principal source of comprehensive state planning and the coordination of inter-regional plans; and

WHEREAS, by Inter-Agency Agreement dated June 18, 1965, the DPW and the DCD established an Inter-Agency Transportation Planning Center (hereinafter called the "Center") to continue the cooperative, comprehensive planning program initiated by the 1962 Agreement and to conduct such research and studies of an Inter-Agency nature as may be assigned to it; and

WHEREAS, since the initial execution of the 1962 Agreement the MAPC was created by Chapter 668 of the Acts of 1963 for the purpose of preparing and revising comprehensive plans for the physical, social and economic improvement of its district, which district consists of 79 of the 152 cities and towns of the planning area; and

WHEREAS, since the initial execution of the 1962 Agreement the MBTA was created by Chapter 563 of the Acts of 1964, and is required to prepare a comprehensive program for mass transportation improvements for its district consisting of 78 cities and towns of the planning area, which improvements shall be consistent with a comprehensive transportation plan prepared by the DPW in consultation with the other agencies and to be adopted by the Board of Commissioners of the DPW pursuant to the provisions of said statute; and

WHEREAS, the 1962 Agreement as amended provided for appointment of a Local Advisory Board to consist of no fewer than five members, who shall be representatives of municipalities within the planning area but not represented in the MAPC.

WHEREAS, it is agreed that it is in the interest of the Agencies and in the public interest and consistent with laws under which the Agencies function that the planning work required to be completed under the provisions of Urban Planning Grant Contract Mass. P34–(G) as herein described (hereinafter called the "P34 Project"), and initiated under the provisions of the 1962 Agreement, shall be completed in a coordinated and expeditious manner and in full cooperation with the cities and towns of the planning area and with other public agencies; and

WHEREAS, it is agreed that the P34 Project shall be completed in such a manner as to support and guide to the maximum degree possible the continuing and future development programs and policies of the Agencies, the cities and towns and other official agencies or instrumentalities and local private organizational groups, in the planning area; and

WHEREAS, under the provisions of the 1962 Agreement the DCD agreed to contribute a sum not exceeding $2.4 million including $1.6 million in the form of an urban planning assistance grant from the HHFA, in conformance with the provisions of the Urban Planning Grant Contract No. Mass. P34–(G) of which approximately $1,025,000.00 remained unexpended and approximately $720,000 remained unencumbered as of August 31, 1965; and

WHEREAS, under the provisions of the 1962 Agreement the DPW agreed to contribute a sum not exceeding $2.4 million, subject to approval of the BPR for the use of Highway Planning and Research Funds by the DPW, of which approximately $1,025,000 remained unexpended and approximately $720,000 remained unencumbered as of August 31, 1965; and

WHEREAS, over and above the aforementioned contribution the DPW agreed to finance the rental, utilities, furniture and office equipment and supplies cost of the P34 Project.

NOW, THEREFORE, it is hereby agreed by and between the parties hereto as follows:

1. The Agencies accept the responsibility for working cooperatively consistent with the State and Federal laws, and to use their best technical and administrative efforts both individually and collectively to carry out the work activities assigned to them as set forth in the P34 Work Program.

a. The P34 Project, which had come to be known as the Boston Regional Planning Project hereinafter called "BRPP" shall henceforth for convenience be designated and known as the EASTERN MASSACHUSETTS REGIONAL PLANNING PROJECT.

b. To the maximum extent practicable, all personnel of the Agencies assigned to the planning work shall be housed in the Center. The housekeeping administration of the Center shall be the responsibility of an office manager assigned by the DPW.

2. The Agencies shall contribute to the P34 Project as follows:

a. The DCD and DPW shall continue to utilize the funds contributed under the provisions of the 1962 Agreement to the P34 Project for the purposed of accomplishing the planning work described below.

b. The Agencies shall provide such staff and other services as will facilitate and accomplish the completion of the P34 Project work activities assigned to them.

c. The DPW shall continue to finance all of the rental, utilities, furniture, office equipment and supplies cost of the Center until such time as other provisions can be made pursuant to Paragraph 3 of the Inter-Agency Agreement executed June 18, 1965 creating a Transportation Planning Center.

3. The P34 Project shall be conducted by the Agencies through a Policy Committee.

a. The Policy Committee shall consist of the following officials of their designees plus such additional members as the Policy Committee may from time to time elect to membership:

Commissioner of the Department of
Commerce and Development

Commissioner of the Department of
Public Works

President of the Metropolitan Area
Planning Council

Chairman of the Board of Directors
of the Massachusetts Bay
Transportation Authority

Chairman of the Local
Advisory Board

b. The Policy Committee shall elect a Chairman from among its members.

c. The Policy Committee shall continue the Local Advisory Board, which shall consist of no fewer than five members, as it was created by the Executive Committee of the BRPP. New members which may from time to time be appointed to the Local Advisory Board by the Policy Committee, shall be representative of a municipality within the planning area but not a member community of the MAPC.

d. The Policy Committee shall from time to time review, modify, approve or disapprove the conduct and progress of the P34 Project including but not limited to work programs, schedules, methods and procedures of a policy nature and recommendations to be formulated and carried out under the provisions of the Agreement, and all reports in preliminary and final form.

e. The BPR and the HHFA shall be given an opportunity to review and act upon all final reports prior to their publication.

4. The planning work being done under the provisions of this Agreement has as its purpose the formulation of a coordinated comprehensive regional plan and development program which is to be accomplished through an evaluation and analysis of several alternative land use and transportation system plans, based upon the collection, analysis and projection of traffic, land use, economic and population data and the evaluation of the interrelationships between land use, economic and population factors and transportation facilities.

5. The Policy Committee shall appoint a Planning Project Director who shall be responsible to it for the overall technical conduct, coordination and integration of the P34 Project, and who shall serve as Secretary of the Policy Committee and Chairman of the Project Technical Committee, hereinafter created. He shall be employed by the DPW for the above purpose.

6. There is hereby created a Project Technical Committee, (hereinafter called the "PTC"), which shall consist of the following officers or their designees plus such additional members as the Policy Committee, upon the recommendations of the PTC, may appoint:

Planning Project Director, Chairman

Deputy Commissioner for Planning,
Department of Commerce and Development

Director of Transportation Planning and
Development, Bureau of Transportation
Planning and Development, Department
of Public Works

Executive Director, Metropolitan
Area Planning Council

Special Assistant to the General Manager
for Planning, Development and Marketing,
Massachusetts Bay Transportation Authority

a. The PTC shall meet frequently and regularly at the call of its Chairman or any member representing the Agencies to report on and to review the progress of the work activities assigned to the respective agencies, resolve conflicts of work schedule and technical substance and make recommendations to the Policy Committee through the PTC Chairman, including majority and minority reports.

b. The Chairman of the PTC shall report to the Policy Committee not less than each month regarding the progress and conduct of the Project. He shall from time to time report any and all recommendations of the PTC and make any other comments pertinent to the Project.

c. Within forty-five (45) days of the date of execution of this Agreement by the Agencies, the PTC shall recommend detailed work assignments and allocation of resources for each Agency to the Policy Committee.

7. The direction of the Work Program elements assigned herein to the respective Agencies shall be the responsibility of the respective Agencies. The expeditious performance of all necessary administrative services to support the technical conduct Work Program elements assigned to the respective Agencies shall be the responsibility of the respective Agencies and shall include but not necessarily be limited to the preparation and processing of all personnel approvals, payrolls, contract payments, vouchers and requisitions.

8. The planning work undertaken by the respective Agencies under the provisions of this Agreement generally shall be as follows, subject to adjustment and refinement in the P34 Project Work Program as it may be approved from time to time by the Policy Committee.

a. The DPW shall:

(1) Continue the collection, analysis and forecasting of transportation data and the determination of future transportation demand by mode through the year 1990, as initiated by the BRPP and based upon the forecasts of future activity to be prepared by the DCD and MAPC.

(2) Continue the development, testing, evaluation and adjustment of transportation networks in accordance with the initial, alternative and comprehensive regional development plans to be prepared by the DCD and MAPC.

(3) Prepare alternative comprehensive, long-range transportation plans consistent with the alternative comprehensive regional development plans prepared by other Agencies which shall include preliminary and general locations and characteristics of highway and mass transportation facilities.

(4) Prepare a recommended short-range and long-range comprehensive transportation development plan, which shall include cost estimates, priorities, staging of projects and proposals for implementation. The details of the mass transportation elements of the plan within the MBTA district shall be developed in cooperation with the MBTA.

(5) In cooperation with the Agencies and other state, regional and local organizations, prepare a statement of goals and objectives and development policies regarding statewide transportation plans and programs to assure the compatibility and consistency of regional plans.

b. The DCD shall:

(1) Initiate the formulation and development of State government goals, objec-

tives and development policies in collaboration with other State agency officials for the purposes of assuring maximum compatibility of P34 Project plans and programs.

(2) Work closely with and through the Local Advisory Board, cities and towns, and other State or regional agencies outside the MAPC district to encourage local participation in the planning process.

(3) Encourage the development of permanent regional planning agencies for each SMSA or combinations thereof.

c. Working cooperatively and jointly to the maximum extent practicable, the MAPC shall for its district and the DCD shall for the remainder of the planning area:

(1) Continue the development of regional goals and objectives in collaboration with local and other public agency officials as already initiated by the BRPP.

(2) Continue the development, revision, refinement and application of the forecasting and planning methodology formulated to date by the BRPP.

(3) Continue the collection, analysis and aggregate forecasting of economic, demographic, housing, land use, fiscal, open space and recreation and other community facilities data and requirements through the year 2000 as already initiated by the BRPP.

(4) Prepare alternative comprehensive regional development plans which shall include but not be limited to land use, open space and recreation and other major community facilities plans which shall set forth the quantitative distribution of population and economic activities in form and detail adequate for transportation planning.

(5) Prepare a recommended short-range and long-range comprehensive regional development plan which shall include but not be limited to land use, open space and recreation and other major community facilities plans which shall set forth the quantitative destribution of population and economic activities in form and detail adequate for transportation planning.

d. The MBTA shall prepare the mass transportation plan for its district as required under the provisions of Chapter 563 of the Acts of 1964 in coordination with the work activities of the P34 Project.

e. Working through the PTC all Agencies shall assist in the preparation and development of all plans and programs and, particularly, shall collaborate to:

(1) Evaluate each of the regional development plan alternatives including the transportation development plan alternatives in the light of their relationship to the transportation networks and traffic distribution forecasts to be prepared by the DPW and the population and economic activity forecasts to be prepared by the DCD and MAPC.

(2) Recommend a comprehensive regional development plan including the comprehensive transportation development plan, based upon the analysis and evaluation of the foregoing plans and studies, which shall include cost estimated, priorities and staging projects and contain specific proposals for plan effectuation.

(3) Recommend a specific program with respect to the design, organization, development and maintenance of a data bank to be housed in the Center which could make available to public and private agencies the appropriate reports, tabulations, punch cards, magnetic tapes and other research data developed in the course of the P34 Project.

(4) Recommend a specific program for the continuing analysis of data; identification and continuous refinement of objectives and criteria; consideration of alternatives; coordination of local plans and of programs and activities affecting the development of the urban areas; and formulation, maintenance and updating of comprehensive plans and of measures to implement plans.

9. The services specified in this Agreement shall be performed according to generally accepted engineering and planning practices consistent with the highest professional technical standards. All services performed under this Agreement shall be in accordance with applicable provisions of Federal and Massachusetts laws and regulations.

10. Each of the Agencies shall make available for examination, upon request by the others, copies of previously prepared reports, maps, plans, surveys, records, regulations, other documents and information in the files of the Agencies and pertinent to the P34 Project or related activities of the Center; and each of the Agencies shall assure the full consistency of the planning work being conducted under the terms of this Agreement with related concurrent studies by regular review of those studies with the PTC.

11. The expenditures required to permit the fulfillment of the obligations incurred under the provisions of this Agreement shall be controlled as follows:

a. All expenditures related to work activities assigned to the DPW or to the MBTA under the provisions of this Agreement shall be processed and paid by the DPW.

b. All expenditures related to work activities assigned to the DCD and MAPC under the provisions of this Agreement shall be processed and paid by the DCD.

c. On or before the 10th day of each month after this Agreement shall become effective, the DCD and DPW shall review jointly their expenditures which became payable in the previous month. The actual processing of payments, expenditures and the related accounting and bookkeeping shall be carried out in a manner to be jointly agreed upon by the Agencies and the Executive Office for Administration and Finance, and consistent with the terms of the Urban Planning Grant Contract governing Project P34.

12. All financial accounts shall be subject to periodic review by the Auditor of the Commonwealth of Massachusetts, the Agencies, BPR and HHFA.

13. This Agreement supersedes the November 30, 1962 Inter-Agency Agreement as amended on February 26, 1964, by and between the DPW and the Mass Transportation Commission, a predecessor agency of the DCD and as further amended on October 30, 1964 in an agreement by and between the DPW and the DCD.

14. The Boston Regional Planning Project and its Executive Committee are hereby redesignated as, and its rights, duties and obligations are hereby transferred to the EASTERN MASSACHUSETTS REGIONAL PLANNING PROJECT, provided however that except as noted in Paragraph 13 above all contracts, inter-agency agreements, obligations and rights in behalf of the BRPP duly in effect prior to the effective date of this Agreement shall continue in full force and effect and shall not be impaired by this Agreement.

15. This Agreement may be executed in any number of counterparts, each of which shall be deemed to be an original.

16. This Agreement shall be binding upon and inure to the benefit of the Agencies and their successors.

IN WITNESS WHEREOF, each of the Agencies has caused this Agreement to be executed on its behalf by its thereunto duly authorized officer as of the day and year first above written.

DEPARTMENT OF COMMERCE AND DEVELOPMENT

o/s T. W. Schulenberg
Commissioner

DEPARTMENT OF PUBLIC WORKS

o/s John D. Warner
Commissioner

METROPOLITAN AREA PLANNING COUNCIL

o/s W. Seavey Joyce, S. J.
President

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

o/s James McCormack
Chairman, Board of Directors

APPROVED AS TO FORM:

o/s John J. Grigalus
Asst. Attorney General

APPENDIX B

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APPENDIX C

GLOSSARY

Accessibility: potential of opportunities for interaction.

Acquisition or Taking: the process of obtaining right-of-way.

All-or-Nothing Assignment: the process of allocating the total number of trips between two zones to the path or route with the minimum travel time.

Arterial Highway: a highway used primarily for through traffic, usually on a continuous route.

Average Daily Traffic: the average 24-hour traffic volume over a stated period, usually one year (also called vehicles per day).

Capacity: the maximum number of vehicles that can pass over a given section of a lane or roadway in one direction during a given time period under prevailing roadway and traffic conditions. It is the maximum rate of flow that can reasonably occur.

Capacity Restraint: the process by which the assigned volume on a link is compared with the practical capacity of the link and the speed of the link is adjusted to reflect the relationship among speed, volume, and capacity.

Circumferential Highway: a highway for carrying traffic partially or entirely around an urban area (also called "belt highway").

Coding: the transformation of a network or informational data into a system of words or symbols which the computer can accept and be instructed to use.

Comprehensive Transportation Planning: the development of long-range transportation plans and programs embracing various modes of transport in a manner that will serve the states and local communities efficiently and effectively. The comprehensive character of the planning process requires that economic, population, and land use factors, terminal and transfer facilities, and traffic control systems be included and that estimates be made of the future demand for all modes of transportation, both public and private, for persons and goods in the entire area that is expected to be urbanized by the end of the forecast period.

Computers: any device capable of accepting information, processing the information, and providing the results of these processes in acceptable form.

Computer Simulation: the use of a computer to reproduce the operation of a system or phenomena likely to occur in actual performance.

Control of Access: the condition where the right of owners of abutting land, occupants of abutting land, or other persons to access, light, air, or view in connection with a highway is fully or partially controlled by public authority.

Full Control of Access: preference given to through traffic by providing access connections with selected public roads only and by prohibiting crossings at grade or direct private driveway connections.

Partial Control of Access: preference given to through traffic to a degree that, in addition to access connections with selected public roads, there may be some crossings at grade and some private driveway connections.

Cordon Line: an imaginary line enclosing a study area.

Core: a large and densely populated center of economic, social, and political activity.

Corridor: a geographic area formed by natural or artificial boundaries that divide a region according to major travel routes.

Corridor Volume: the number of vehicles per day passing a screenline on parallel roadways in a given corridor.

Delay: the time consumed while traffic or a specific component of traffic is impeded in its movement by some element over which it has no control.

Divided Highway: a highway with separated roadways for traffic in opposite directions.

EMPIRIC Land Use Forecasting Model: a mathematical model for forecasting patterns of land use activities, based on measured relationships between changes in land use and changes in certain policy variables, such as transportation systems, water and sewage systems, etc.

Expressway: a divided highway for through traffic with full or partial control of access and generally with grade separations at intersections.

Gravity Model: a mathematical model of trip distribution based on the premise that trips produced in any given area will distribute themselves in accordance with the accessibility to other areas and the opportunities they offer.

Highway or Street: a general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

Highway Grade Separation: a structure used to separate vertically two or more intersecting roadways, thus permitting traffic on all roads to cross traffic on all other roads without interference.

Interchange: a system of interconnecting roadways providing for the interchange of traffic between two or more roadways on different levels.

Ramp: connection between highways at different levels, or between parallel highways, on which vehicles may enter or leave a designated roadway.

Historic Sites: structures or areas of significant federal, state, or local historical or architectural value.

Intersection: the general area where two or more highways join or cross, within which is included the roadway and roadside facilities for traffic movements in that area.

Joint Development: multiple use of the space above and below the highway, as well as alongside it, in such a way that the entire space is planned and shaped as an integrated whole.

Kiss-Ride: a transit trip made by a rider who is dropped off or picked up at a transit station.

Land Use: the type of development or activity on each parcel of real estate.

Level of Service: a qualitative measure of the effect of a number of factors, including speed and travel time, traffic interruptions, freedom to maneuver, safety, driving comfort and convenience, and operating costs. In practice, selected specific levels are defined in terms of particular limiting values of certain of these factors.

Link: a segment of the transportation system.

Mass Transportation: the movement of large groups of people in vehicles operating on specified routes and schedules. Mass transportation service is provided by both public and private agencies. (Also called public transportation.)

Megalopolis: a large urban area resulting from the growth and sprawl of many cities into one continuous, intensely developed band or ring.

Merging: the process by which two separate traffic streams moving in the same general direction combine to form a single stream.

Metering of Ramp: control of the flow of vehicles using an expressway entrance ramp by a traffic signal or other device.

Minimum Path: that route of travel between two points which has the least accumulation of time, distance, or other parameter to traverse.

Modal Split: the term applied to the division of person trips between public and private transportation.

Mode of Travel: means of travel, such as auto driver, vehicle passenger, mass transit passenger, or walking.

Model: a representation of an object, event, process, or concept that is used for prediction and control. By manipulating the model, the effects of changing one or more aspects of the entity represented can be determined.

Open Space: the land reserved from development and intended for recreational use or the enjoyment of nature.

Park-Ride: a transit trip made by a rider who arrives at or leaves the transit station in a vehicle that is parked near the station for the duration of the trip.

Peak-Load Point: the portion of each transit line which carries the maximum number of daily line passengers.

Personal Business Trip: trip to complete personal business transactions not considered as duties of employment, such as paying a bill, going to the bank, mailing a letter, eating at a restaurant, visiting the doctor, etc.

Radial Highway: an arterial highway leading to or from an urban center.

Rotary Intersection: a confluence of three or more intersection legs at which traffic merges into and emerges from a one-way roadway in a counterclockwise direction around a central area.

Screenline: an imaginary line, usually along physical barriers such as rivers or railroad tracks, splitting a study area into two parts.

Socioeconomic: a combination of social and economic values.

System: (1) a complex unity formed of many diverse parts. (2) an aggregation of objects joined in regular interaction or interdependence. (3) any set of objects or events with relationships between them or their attributes.

Terminal Time: the travel time required to unpark or to park and the additional walking time required to begin or complete the trip.

Traffic: all types of conveyances, together with their loads, either singly or as a whole, while using any roadway for the purpose of transportation or travel.

Traffic Assignment: the process of determining routes of travel and allocating the zone-to-zone trips to these routes.

Traffic Control Signal: any device, whether manually, electrically, or mechanically operated, by which traffic is alternately directed to stop and permitted to proceed.

Traffic Engineering: the phase of engineering which deals with the planning, geometric design, and traffic operations of roads, streets, and highways, including their networks, terminals, abutting lands, and relationships with other modes of transportation, for the achievement of safe, efficient, and convenient movement of persons and goods.

Travel Time: the time required to travel between two points, including the terminal time at both ends of the trip.

Trip: a one-direction movement which begins at the origin at the start time, ends at the destination at the arrival time, and is conducted for a specific purpose.

Trip Distribution: the process by which the movement of trips between zones is estimated. The distribution may be measured or estimated by a growth factor process or a synthetic model.

Trip End: either a trip origin or a trip destination.

Trip Generation: the process by which the number of trips beginning or ending in a zone is estimated. Trip rates or equations are applied to socioeconomic values to obtain the trip ends for each zone.

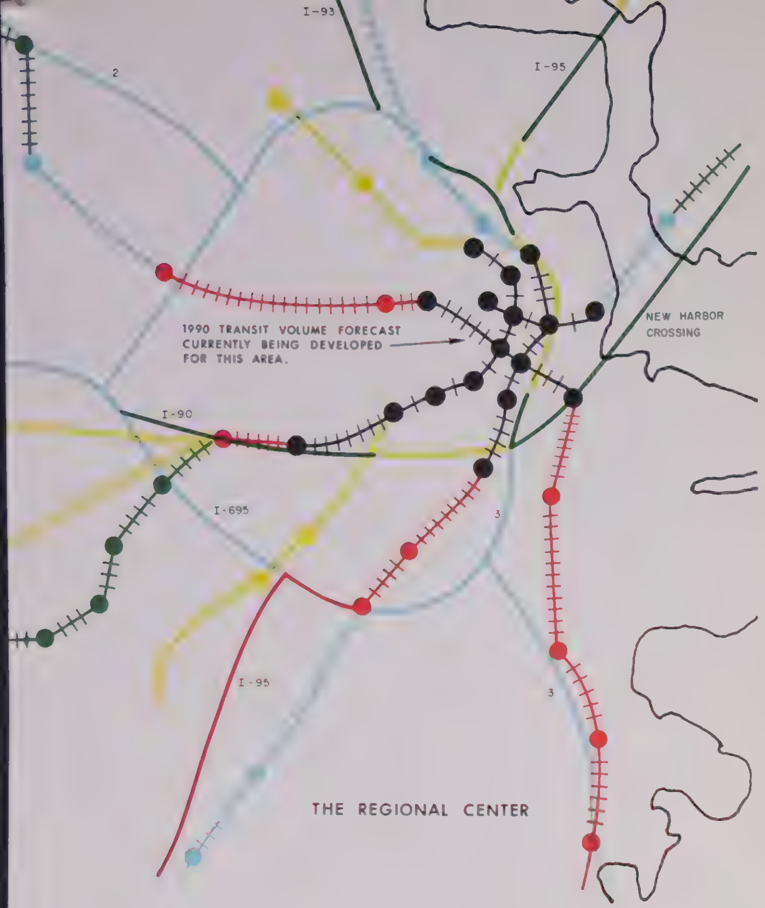
Trip Interchange: a trip between two different zones.

Vehicle: any component of wheeled traffic.

Volume: the number of vehicles passing a given point during a specified period of time.

Weaving: the crossing of traffic streams moving in the same general direction, accomplished by merging and diverging.

Zone: a portion of the study area delineated for particular land use and traffic analysis purposes.


I-93
I-95
2
NEW HARBOR CROSSING
1990 TRANSIT VOLUME FORECAST CURRENTLY BEING DEVELOPED FOR THIS AREA.
I-90
I-695
3
I-95
3
THE REGIONAL CENTER

PLAN C

RADIAL CORRIDOR HIGHLIGHTS

1963	1990		1963	1990
NORTHEAST CORRIDOR			WESTERN CORRIDOR	
590,680	758,387	POPULATION	549,141	757,718
173,714	250,394	EMPLOYMENT	199,281	274,120
178,152	342,412	AUTOMOBILE OWNERSHIP	189,692	405,165
1,169,108	1,598,352	TOTAL PERSON TRIPS	1,123,183	1,722,003
52,338	66,188	PERSON TRIPS TO BOSTON CORE	79,274	111,505
91,679	92,785	TRANSIT PERSON TRIPS	83,968	101,959
25,589	26,459	TRANSIT PERSON TRIPS TO BOSTON CORE	31,774	41,158
862,872	1,240,421	HIGHWAY VEHICLE TRIPS	883,525	1,373,836
22,896	35,617	HIGHWAY VEHICLE TRIPS TO BOSTON CORE	37,470	55,244
NORTHERN CORRIDOR			SOUTHWEST CORRIDOR	
810,615	997,668	POPULATION	454,343	653,076
241,793	338,239	EMPLOYMENT	107,476	209,170
236,944	438,032	AUTOMOBILE OWNERSHIP	131,841	315,337
1,406,216	2,107,135	TOTAL PERSON TRIPS	786,975	1,371,180
65,291	80,223	PERSON TRIPS TO BOSTON CORE	63,485	90,033
109,523	132,117	TRANSIT PERSON TRIPS	93,273	96,761
29,345	32,064	TRANSIT PERSON TRIPS TO BOSTON CORE	32,927	35,210
1,104,993	1,681,817	HIGHWAY VEHICLE TRIPS	588,378	1,114,139
28,274	37,491	HIGHWAY VEHICLE TRIPS TO BOSTON CORE	25,618	43,608
NORTHWEST CORRIDOR			SOUTHEAST CORRIDOR	
292,794	414,592	POPULATION	724,839	1,051,032
90,892	135,624	EMPLOYMENT	182,576	307,207
97,949	212,635	AUTOMOBILE OWNERSHIP	211,261	476,606
519,595	911,984	TOTAL PERSON TRIPS	1,250,684	2,215,410
51,779	62,967	PERSON TRIPS TO BOSTON CORE	97,357	114,102
59,935	70,990	TRANSIT PERSON TRIPS	139,179	160,559
21,588	23,841	TRANSIT PERSON TRIPS TO BOSTON CORE	43,798	47,747
397,774	720,985	HIGHWAY VEHICLE TRIPS	982,355	1,741,355
25,403	32,242	HIGHWAY VEHICLE TRIPS TO BOSTON CORE	46,918	56,417

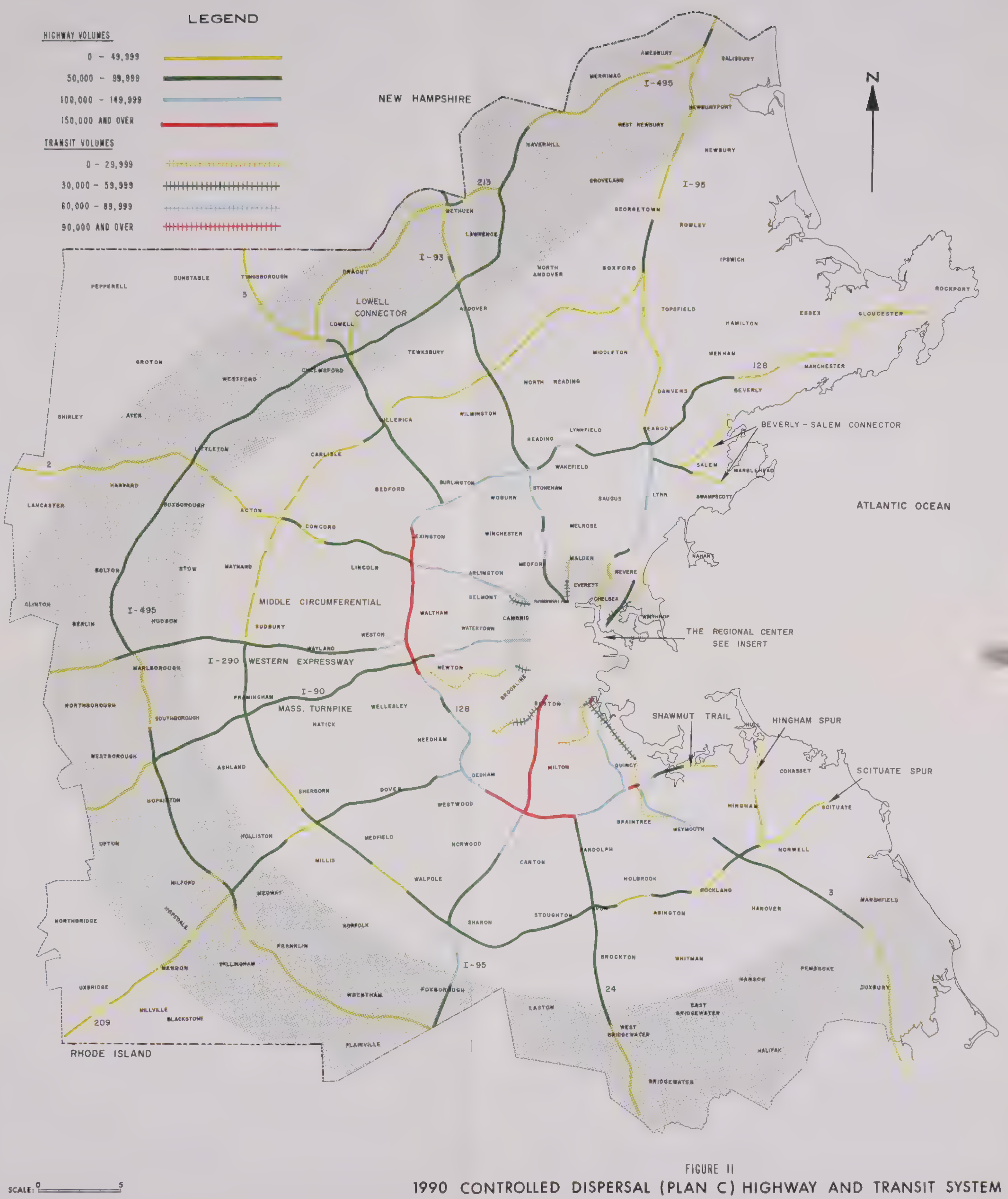
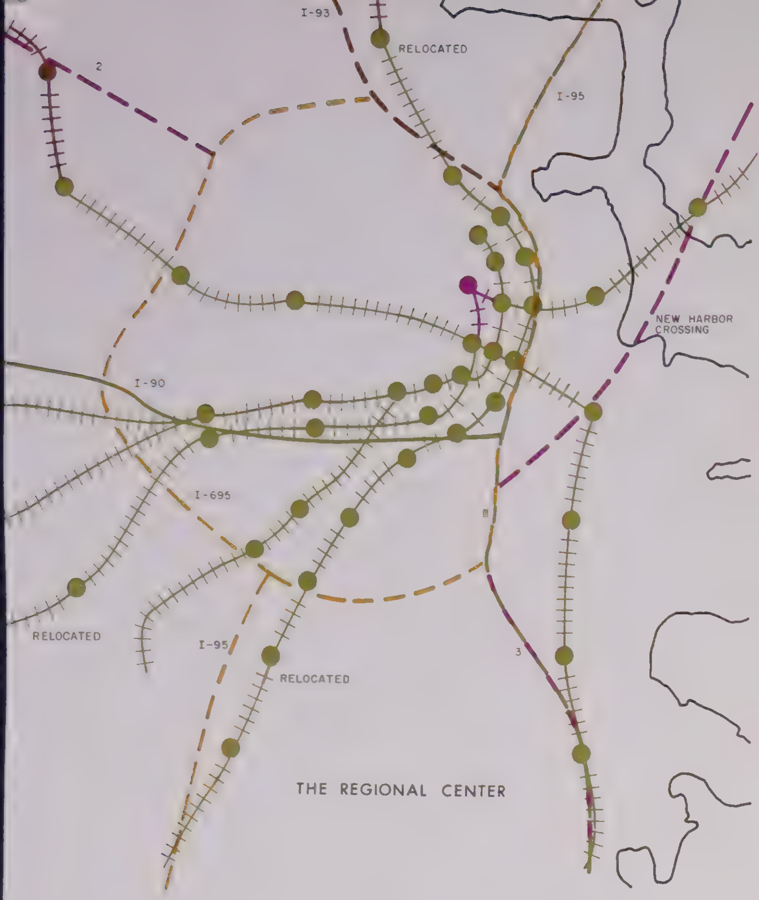


FIGURE II

1990 CONTROLLED DISPERSAL (PLAN C) HIGHWAY AND TRANSIT SYSTEM

PREPARED BY
MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
BUREAU OF TRANSPORTATION PLANNING AND DEVELOPMENT
THROUGH
EASTERN MASSACHUSETTS REGIONAL PLANNING PROJECT
IN COOPERATION WITH THE
UNITED STATES DEPARTMENT OF TRANSPORTATION - BUREAU OF PUBLIC ROADS
OCTOBER 1968



RECOMMENDED HIGHWAY AND TRANSIT PLAN

TOTAL COSTS FOR SHORT- AND LONG-RANGE PROGRAMS

		(Thousands of Dollars)			
1968-1975	Length (Miles)	Federal Aid	State Funds or MBTA Bonds	Total To Be Funded	Total
Expressway	33.1 29.2[a]	447,522	83,440	530,962	530,962
Rapid Transit	9.0	0	46,000	41,000	46,000
Subtotal		447,522	129,440	571,962	576,962
1975-1990					
Expressway	146.1 40.8[a]	218,170	362,170	580,340	580,340
Rapid Transit	29.5 11.0[a]	208,200	104,200	312,400	312,400
Subtotal		426,370	466,370	892,740	892,740
Total Expressway	179.2 70.0[a]	665,692	445,610	1,111,302	1,111,302
Total Transit	38.5 11.0[a]	208,200	150,200	353,400	358,400
TOTAL SHORT- AND LONG-RANGE PROGRAMS		873,892	595,810	1,464,702	1,469,702

[a] Upgrading of facilities.

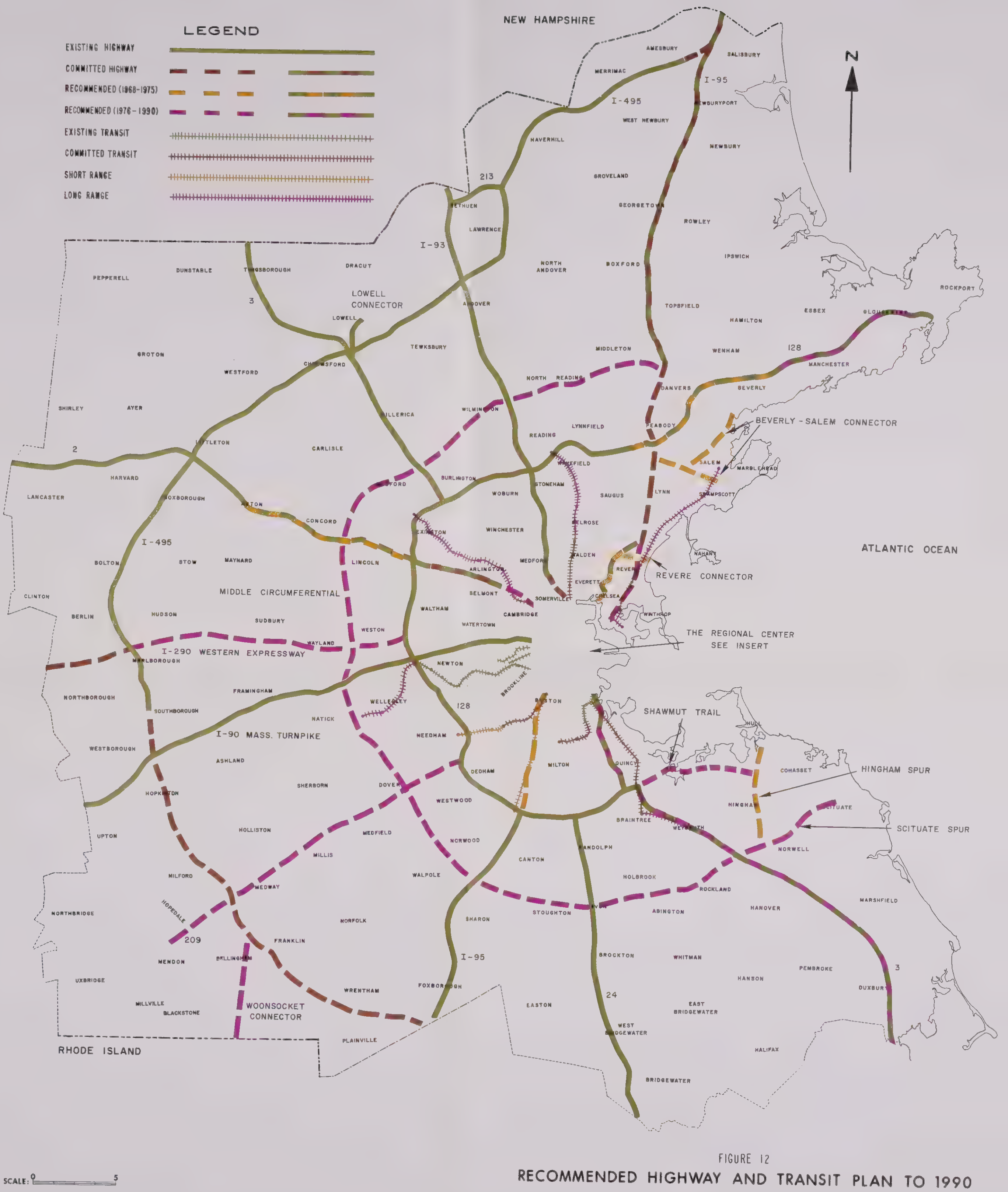


FIGURE 12

RECOMMENDED HIGHWAY AND TRANSIT PLAN TO 1990

PREPARED BY
MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS
BUREAU OF TRANSPORTATION PLANNING AND DEVELOPMENT
THROUGH
EASTERN MASSACHUSETTS REGIONAL PLANNING PROJECT
IN COOPERATION WITH THE
UNITED STATES DEPARTMENT OF TRANSPORTATION-BUREAU OF PUBLIC ROADS
OCTOBER 1968

Section 9 of the Federal-Aid Highway Act of 1962, approved October 23, 1962, amended Chapter 1 of title 23, United States Code, by the addition of a new section 134, which reads as follows:

> "It is declared to be in the national interest to encourage and promote the development of transportation systems embracing various modes of transport in a manner that will serve the states and local communities efficiently and effectively. To accomplish this objective the Secretary shall cooperate with the States, as authorized in this title, in the development of long-range highway plans and programs which are properly coordinated with plans for improvements in other affected forms of transportation and which are formulated with due consideration to their probable effect on the future development of urban areas of more than fifty thousand population. After July 1, 1965, the Secretary shall not approve under section 105 of this title any programs for projects in any urban area of more than fifty thousand population unless he finds that such projects are based on a continuing comprehensive transportation planning process carried on cooperatively by State and local communities in conformance with the objectives stated in this section."

Extract from Bureau of Public Roads Instructional Memorandum 50-2-63 March 27, 1963:

> 5. Cooperatively – The establishment of a formal procedure – supported by a written memorandum of understanding – between the State highway departments and the governing bodies of the local communities for carrying out the transportation planning process in a manner that will insure that the planning decisions are reflective of and responsive to both the programs of the State highway department and the needs and desires of the local communities. The agreement may be directly between State highway department and the local governing bodies or by way of an agreement between the State highway department and an agency or agencies embracing the urban area encompassed in the transportation planning process qualified to act in behalf of the local jurisdictions for this purpose.